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160-TON HYDRAULIC CRANE.

For some time past Messrs. Sir William Armstrong & Company have had in course of construction at Elswick six guns, each weighing no less than 100 tons, for the Italian Government. The manufacture of such guns at all is a remarkable feat, but it is obvious that something more is required—the guns when finished must be delivered. To this end Messrs. Armstrong have erected at their works a colossal shears, competent to lift 120 tons, while a crane of 160 tons has been nearly completed for the Italian Government, to lift the guns in and out of the ships in which they will be fought. Below we give a drawing of this crane, with a 100-ton gun suspended from it. The platform of this crane revolves upon a live roller frame of 43 ft. diameter. At the rear of the platform is a counter-weight box, carrying about 350 tons to counterpoise not only the weight of the crane itself but of the load, so that no lifting strain is brought upon the central pivot. The crane stands upon a masonry and concrete pedes-

NEW DECOMPOSING FURNACE

By R. C. CLAPHAM, F.C.S.

(A paper read at the Newcastle Chemical Society, March 23d, 1876.)

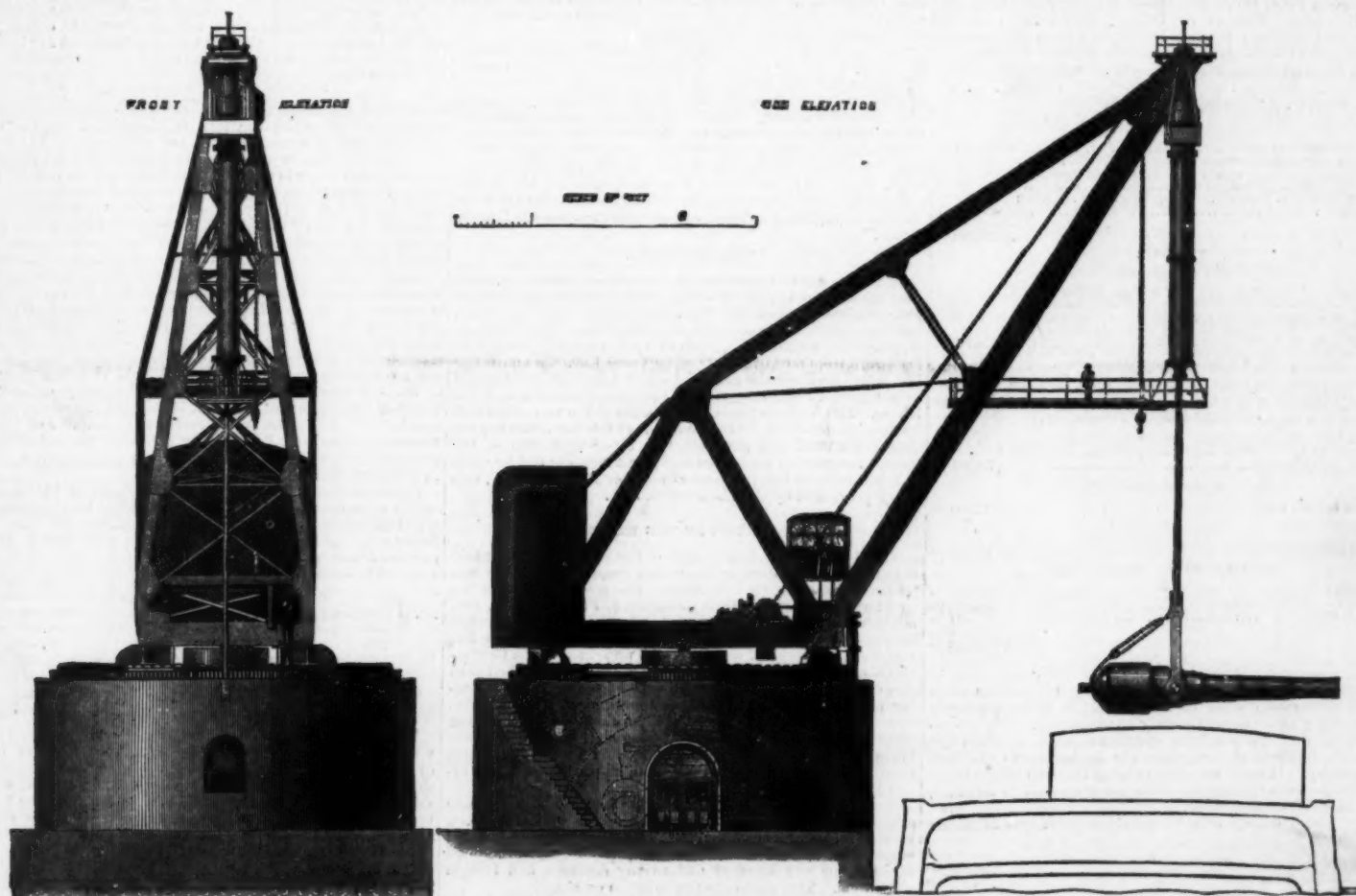
THE best methods of decomposing salt with sulphuric acid have long attracted the attention of manufacturers, for it is admitted on all sides that those adopted in practice have been unsatisfactory—leading to expenses from the partial stoppage of work by the breakage of pans, and also to a waste of sulphuric acid.

When the present system of making soda was commenced on the Tyne, in 1820, the chemical trade was in its infancy, and small lead-pans lined with brick-work were used to decompose salt, a charge of 2 cwts. of salt was taken, and sulphuric acid was slowly poured upon it from a carboy through a hole in the roof of the furnace, and it took three hours to complete the operation. But as these lead-pans were so lie-

nace which was laid off a few days ago, I found the plates as fresh and good as when erected.

The furnace now in actual work, and from which fixed and regular results are obtained, consists of a metal dish divided into six segments, all tightly fixed together. The metal is $2\frac{1}{2}$ inches thick, and the whole rests on solid brick-work. The diameter is 15 feet, and the charge of salt is about 13 tons each twenty-four hours; so that a furnace of this capacity will turn out about 80 tons sulphate of soda in six days. The batch is kept in constant motion by means of two cross metal arms worked from a central shaft, to which are fixed paddles and rakes, and the whole mass is much more completely mixed than in a hand worked furnace, and the sulphate produced is of a very fine and uniform character. Mr. Walsh who is present, has kindly undertaken to explain the furnace more fully from the working model on the table and from the plans exhibited.

The motion supplied to the crown wheel is got from a dou-



160-TON HYDRAULIC CRANE.

tal, 20 ft. high and 50 ft. in diameter, the outer wall of which carries the path on which the live roller ring runs, the centre being hollow, and serving as a house for the boiler and pumps supplying the water-pressure for working the crane. The work of lifting is done by an inverted hydraulic press, hung in gimbals, on a system invented by Mr. Rendel. The pumps are arranged to act direct upon the lifting-press and turning-engine of the crane, without the intervention of an accumulator. The crane is revolved by an hydraulic rotary engine, which also drives a winch connected with a chain passed over a pulley on the head of the jib, and available for lifting light loads. The rake is 65 ft., so that the crane commands a very large surface of the quay, and could, if requisite, set down many monster guns within its sweep—a great advantage the crane possesses over shears, and one which will be especially important in the case of weights like those it is intended to lift, which can not be stored, except at great cost, beyond the reach of the machinery provided for lifting them. This crane is for the Arsenal of Spezia, where the foundations for it are now nearly completed. The whole of the eight 100-ton guns which it is destined to lift may, with their carriages, be placed together under its sweep.—*The Engineer*

CORNISH PUMPING-ENGINES.

THE number of English pumping-engines reported for February is 17. They have consumed 1657 tons of coal, and lifted 12,900,000 tons of water 10 fms. high. The average duty of the whole is, therefore, 33,700,000 lbs. lifted 1 foot high, by the consumption of 112 lbs. of coal.

ble to be injured, a fire-brick furnace was substituted in 1838, which was then looked upon as an improvement, and was well known locally as "The Dandy Furnace." At that time no attempt was made at the condensation of the hydrochloric acid fumes, and they passed directly into the atmosphere.

A great improvement on the above was introduced in 1840 by the late Mr. John Lee, who applied a metal pan about the same size as we now use, and its adoption by the trade has led, amongst other advantages, to a large saving of sulphuric acid. This pan has, however, been always liable to frequent breakages from negligence of workmen and other causes, and to get over this difficulty various substitutes have at times been tried. In 1860 I had some fire-clay pans made at the Scotswood Brick Works, which were used at the Walker Alkali Works. They were found to work pretty well, but were difficult to heat, and were at last given up.

If we grant that the life of an ordinary decomposing pan is long enough to turn out 2000 tons of salt (and many of those present know that in many cases 1000 tons is a fair quantity), I calculate that on the Tyne alone not less than £5000 per annum is spent in the renewal of decomposing pans; and when we take into account the loss of time caused by the breakage, the extra labor required, and a waste of acid, the money loss under these heads will be very considerable also.

In the face of these facts there would appear to be ample room for improvement. Messrs. Wm. Jones and John Walsh, of Middlesborough, have contrived and erected a new kind of decomposing furnace which completes the operation in one furnace. It has now been at work several months, and from an examination of the plates forming the dish of a fur-

key-engine, and a small engine with a 6-inch cylinder is found to be sufficient to work the furnace. The batch is both charged into the furnace and discharged by hand, but Mr. Goodman expects to perfect a plan to do this by machinery.

The advantages to be derived from this new furnace may be described as a more regular daily means of working; free from sudden stoppages by breakage of the present pans; a direct saving in wages, as only one workman is required to each shift for charging and working the furnace; a saving of fuel, as the heat required is less than in the old furnace; and 3 cwts. coke per ton of sulphates is used in the place of 9 cwts. coal (=5½ cwts. coke) by the old furnace; a saving, also, of sulphuric acid, calculated by Mr. Walsh to be equal to about 1½ to 2 per cent. Then, again, owing to the complete mixing and better working of the batch by machinery, the great inconvenience felt by the public living in the neighborhood of chemical works by the batches being frequently drawn by the workmen in a partly finished state, and containing free hydrochloric acid, is entirely avoided. The fumes being emitted in a gradual and uniform manner throughout the working of the batch, the condensation is more perfect, and as the whole of the gas is passed through one coke tower it is condensed into hydrochloric acid of 26° to 28° T., hot. It appears that both in an economical and sanitary point of view this furnace is an improvement upon its predecessors.

In the description I have given I have purposely confined myself to a furnace in actual daily work, and from which known results have been obtained; but there is a fair probability that experience will show that not less than 100 tons weekly will be turned out of each furnace.

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THE INTERNATIONAL EXHIBITION OF 1876.

OPENS MAY 10TH, CLOSES NOVEMBER 10TH.

At a recent meeting of the stockholders of the United States Centennial Exposition, directors were chosen for the year, a financial statement made, and other particulars given.

DIRECTORS CHOSEN.

John Welsh, William Sellers, Samuel M. Felton, Daniel M. Fox, Thomas Cochran, Clement M. Biddle, N. Parker Shortridge, James M. Robb, Edward T. Steel, John Wanamaker, John Price Wetherill, Henry Winsor, Amos R. Little, John O. James, Thomas H. Dudley, New-Jersey; A. S. Hewitt and William Strong, New-York; John Cummings, Massachusetts; John Gorham, Rhode Island; Charles W. Cooper, Pennsylvania; William Bigler, Pennsylvania; Robt. M. Patton, Alabama; John S. Barbour, Virginia; J. B. Drake, Illinois; George Bain, Missouri.

RECEIPTS.

Stock subscriptions.....	\$2,128,140 30
Donations, medals, concessions, etc.....	327,587 15
State of Pennsylvania, subscription.....	543,343 78
City of Philadelphia, subscription.....	1,190,084 95
Received from U. S. Treasury.....	500,000 00
Loans, etc.....	408,907 17
Total.....	\$4,108,063 25

PAYMENTS.

Centennial Buildings and Grounds.
On account of buildings, and for grading, drainage, and laying out grounds, water-works, gas-main, machinery, plans, salaries of engineers and architects, clerks, printing, advertising, stationery, and all other charges incident to said buildings and grounds.....\$4,178,101 44

United States Centennial Commission.
For salaries, clerk-hire, printing, advertising, plans, and other charges.....\$46,329 01

Centennial Board of Finance.
Salaries, clerk-hire, rent, printing, advertising, stationery, commissions to agents, fire and police departments, and other charges and expenses.....195,506 96

Memorial Medals.
For dies, bullion, coinage, cases, etc.....25,808 55

Temporary Loans.
Paid on account of money borrowed.....140,000 00

TREASURER OF THE UNITED STATES.

Advanced for engraving and printing memorial certificates.....	24,500 00
Balance on deposit in banks.....	994,435 76
Cash in office.....	311 53
Total.....	\$1,019,036 25

APPROXIMATE OF EXPENDITURES.

So many agencies are in action, drawing the various parts of our preparatory work to a close, that it is impossible to speak other than approximately of the outlay. We see no reason to vary the estimate, which was eight millions five hundred thousand dollars, from the beginning to the final winding up. It must be borne in mind that the expenditure incident to an exhibition on so large a scale can, in advance, only be given conjecturally.

The whole outlay will be provided from the following sources:

State of Pennsylvania.....	\$1,000,000
City of Philadelphia.....	1,500,000
Concessions, gifts, and interest.....	500,000
Stock subscriptions.....	2,800,000
Appropriation by the United States.....	1,500,000
Total.....	\$7,000,000

As this shows a deficiency of one million five hundred thousand dollars, that amount must be supplied from admission fees.

Assuming that our present assured means are equal to the payment of every thing up to the opening, and that for the expenses of the Exhibition, until the final winding up of its affairs, there will be required one million five hundred thousand dollars from the receipts for admission fees, then whatever sum beyond that shall be realized from admissions, together with the value of the materials after its close, will be applicable to the repayment of the capital stock and the United States appropriation; the interests of the State of Pennsylvania and the city of Philadelphia being represented by their respective buildings, the Machinery, Memorial, and Horticultural Halls.

ADMISSION AND ENTRANCES.

In the arrangements connected with the entrance and exit of visitors, exhibitors, and employees, the greatest simplicity has been aimed at. Each class will use special gates. The tickets for visitors will be a fifty-cent note, and if not in the possession of the visitor it can be obtained in exchange for other money at an office near each gate of entrance. Children pay the same as adults. To vary from a uniform price entails so many inconveniences as to forbid it. Fifty cents for nine hours' visit to a museum of the products of the world, distributed among beautiful buildings and on grounds of surpassing attractions, must be satisfactory to every one. Such exhibitors and employees as are required on the grounds will be furnished with special tickets.

EXTENT OF THE EXHIBITS.

The available space in all the buildings is disposed of. The representations from foreign nations will be larger, and their exhibits of greater interest and larger value, than were anticipated; and those from our country, although not forming a perfect representation of it in all its parts, will be very general and of great interest. In every respect the Exhibition will far exceed the expectation of its projectors, and present a study worthy of the attention of the most cultivated minds of the age. Its educational value can not be over-estimated. Its influence as a commemoration must be most salutary.

CONVENIENCES ON THE GROUNDS.

Cafes in the buildings and restaurants without are liberally provided. A department for Public Comfort will furnish private dressing-rooms and lavatories, with every facility for the keeping and transit of baggage from one point to another within the grounds; rolling-chairs will be in readiness at convenient places for the carriage of those who prefer to use them in passing through the grounds and the buildings; rail-cars will be constantly traversing a route in easy proximity to all points of interest; a lift will place those who wish to have a bird's-eye view of the miniature city on an elevated point; a safe deposit company has a position in the Main Building, which will, on its own responsibility, take charge of valuables for those whose convenience may be promoted by its employment; the Centennial National Bank has an office for use by exhibitors and visitors as a place of deposit for money, the negotiation of letters of credit, the conversion of foreign gold, the purchase and sale of bills of exchange, and it has also in its charge the sale of our Centennial medals, which are designed to be a memento of the occasion, and are authorized and protected by the laws of the United States.

A CURIOUS JAPANESE BOOK.

The Honolulu (Hawaii) Gazette says: "Perhaps the most remarkable of the contributions of Hawaii to the Centennial Exhibition are a couple of volumes of Bowditch's *Navigator*, in the Japanese language, which are sent by Rev. Dr. Damon, of this city. The work is one of twenty copies which were all made by hand, and with incredible neatness and skill, in Japan, about twenty years ago.

"The translator of the book, Mung, now known as Captain Mungero, has had a most checkered and eventful career. About the year 1839, when he was quite a boy, he was on board of a fishing-junk which was blown off to sea and wrecked on an uninhabited island. There he and his companions remained for six months, when he and two others were taken off by Capt. Whitfield, of the ship John Howland, and brought to Honolulu. His comrades remained here, and Mung went on with Capt. Whitfield to the United States and remained there several years, where he received the ordinary education of a New-England boy, giving especial attention to the science of navigation."

THE EXIT-GATES.

The exits are of ingenious contrivance, and, while permitting freely the departure of persons from the Exhibition grounds through turn-stiles will absolutely prevent re-entrance, although no officer is required to watch them. They will resemble small roofed sheds, with two gates opening inward or backward from a centre post on the fence line. When a visitor desires to leave the ground, he will have to place himself in a triangle, formed by two of the turn-stile arms and the fender. As he moves forward and outward the turn-stiles will move with him until he finds himself at the gate. He can not change his mind and get back, this being prevented by the outward movement controlled by the ratchet, nor can he come in again without the payment of another fifty-cent note, this being prevented by the fixed lateral bars.

HORTICULTURE AT THE EXHIBITION.

The Horticultural Department of the Exhibition will probably show, besides ample American contributions, very extensive varieties of foreign plants. Specimens of Australian tree ferns have arrived from California. From Jamaica, Bermuda, and other English colonies, where immense botanical gardens are supported by government subsidies, some fine varieties are expected, which may be presented to the Centennial Commission as the nucleus of a botanical collection in this country. The chances of life of bulbs, roots, and growing plants sent from the tropics are precarious; yet Cuba, Mexico, and Brazil will try the experiment of transporting them hither. France, Germany, England, and the Netherlands will be moderately represented in the Horticultural grounds. A remarkable specimen of rhododendrons has arrived among the English imports.

The Horticultural grounds comprise forty acres. The space available for outside exhibits, besides the walks, borders, building sites, and spaces for ornamental gardening, is about eight and one third acres. This is pretty nearly all applied for by about one hundred and twenty domestic and foreign exhibitors. The walks are two miles in extent.

Parterres and sunken gardens are laid off and planted so as to show leading features of ornamental gardening, such as carpet-bedding, ribbon and geometrical gardening; and these will bloom near the opening-time of the Exhibition. The above and the following particulars are from the New-York World. About 50,000 flowering and ornamental varieties of plants and foliage will decorate the beds and represent different flower-gardening methods. There is to be an impressive show of forest trees, ornamental trees, shrubs, and plants of commerce. All the representative trees of this country will be exhibited, from the California red-wood and the Maine pine, down; and we are promised some shrubs of recent introduction from China and Japan. Fountains, statuary, kiosks, summer-houses, and other garden adornments will help to beautify (it is to be hoped without overcrowding) the delightfully situated and shaded Horticultural grounds.

The Horticultural Building stands on an artificial elevation ornamented by artistic terraces and reached by flights of marble steps. Its bright colors and graceful proportions render it perhaps the most attractive of the principal five buildings of the Exhibition. On the north and south sides of the central main hall—the ceilings of which are brilliantly garlanded, and the floors elaborately paved—are the four green-houses, each 30x100 feet. These and the main hall are heated by hot water, and set apart for choice plants of commerce and exotics. The main hall, 80x230 feet, has in the centre a marble fountain surrounded by choice tropical plants, statuary, and specimens of ceramic art. The warming apparatus is very interesting. Four large return-flue boilers are placed in the basement of the main hall, connected by a system of iron pipes laid horizontally under the floor of the passageway. The pipes convey the water to and from the boilers. Thus, by a propulsion of heat, water is kept in motion throughout

the building, furnishing a temperature about equal to that of the climate of Madeira. In the forcing-houses there is a similar heating system, except that four fire-box boilers are used, and the pipes are laid above the floor. An ingenious use of the connecting valves lets either house be heated separately; or one or all of the boilers can be used, and some or the whole of the pipes at pleasure. In case of accident, any boiler can be instantly shut off from the general connection.

NATIONAL ACADEMY OF SCIENCES.

THE annual meeting of the National Academy of Sciences was convened at Washington, at the Smithsonian Institution, on the 20th of April, Prof. Henry in the chair.

TUNING-FORKS.

"I find it difficult to contrive a suitable title for my paper," said Prof. A. M. Mayer, of the Stevens Technological Institute, Hoboken. There is evidence of the embarrassment in the title furnished, as follows: "On the Precise Determination of the Number of Vibrations of Tuning-forks, and on the Effect of Temperature and of Amplitude of Vibration on the Vibratory Periods of Forks." The paper was not so discouraging as its title. It appears that tuning-forks are now largely used for determining short periods of time, by means of apparatus involving their vibrations. Among these uses, one of the most prominent is in ascertaining the rate of flight of projectiles; another is for pathological experiments upon the rate and character of the pulse; still another is connected with telegraphy, both as to the absolute speed of the electric current and as to determinations of longitude. But the results obtained in these researches are slightly vitiated by errors of which the sources and laws have been as yet very little ascertained. It has been customary to ascribe the greater portion of these errors to differences of temperature. Instruments have been constructed at great expense to indicate the exact measure of time taken by tuning-forks for their vibrations, but little certainty was obtained because of the difficulty of making the recording cylinders revolve, and the rest of the apparatus conform, with the needful accuracy.

Prof. Mayer has contrived an instrument in which variations of the rate of revolution of the recording cylinder do not affect the point at issue. He first fixes a pointed rod at the end of a pendulum (moved by a clock) so that the point, when at the lowest part of each beat, shall touch a globule of mercury. This touch to the globule completes an electric circuit leading to a tuning-fork which is standing so close to a revolving cylinder that when the fork is vibrating, a point on the fork describes a wavy line on the cylinder. (If the fork were not vibrating, it would mark a straight line on the cylinder when the latter is rotated.) At the instant of contact between the pendulum and mercury, a spark passes from the point on the fork to the cylinder. Upon the cylinder there is stretched a sheet of smoked paper, on which the wavy line of vibration is continually traced. When the spark passes, it goes through the paper. Two or three sparks may come with the contact, but only the first one goes through the paper. Thus the length of time between the beats of the pendulum is measured on the wavy line, and, as the number of waves in the line is the number of vibrations of the tuning-fork, it follows that by counting the number of waves between each spark-hole, we have the number of vibrations of the fork in a given time, say a second. Evidently the rate of revolution of the cylinder is not concerned, as the only difference, whether that goes fast or slow, is to make the waves closer together or wider apart on the record; the number of waves remains unaffected. Prof. Mayer exhibited several of these records which had been fixed by dipping the blackened paper in a thin varnish.

Professor Mayer first tested the correctness of the forks—which come stamped with a note that should indicate exactly a certain number of vibrations in a second. At 60° Fahr., he found only one fork in six was correct; one was 3 beats, another 5 beats, another 12 beats in 60 seconds out of the way. Then he proceeded to ascertain the exact effect of change of temperature. This was tabulated as follows:

No. of Vibrations.	Name of Note.	Variation with 1°.
128	Ut 2	.006
256	Ut 3	.012
384	Sol 3	.016
512	Ut 4	.023
640	Mi 4	.030
1024	Ut 5	.046

The numerical relation of these results to the number of vibrations of the fork is obvious. It follows that the effect of a change of temperature is, for 1 degree, one twenty-two thousandth of the length of a vibration, or, rather, of the vibratory period. To reduce this to a rule, it may be stated that the effect of temperature on any fork is to be simply ascertained by multiplying the number of its vibrations per second by the decimal .00004545. Applying this rule for example to Ut 3—that is, multiplying the foregoing decimal by 256—we have .011645; that is, little over one hundredth. It hence is evident that even a difference of 10° in temperature during the use of a tuning-fork to measure the velocity of a projectile would not make a serious difference in the record. This is a very important conclusion, as it differs widely from the belief among experimenters at West Point. It was also shown that the changes in the amplitude of the vibration of a fork—as for instance between its first start and when it was near stopping, or in the checking of the movement caused by the point pressing against the cylinder—had no notable effect on the number of vibrations per second.

SIMULTANEOUS IGNITION OF FUSES.

General Henry L. Abbot read a paper on the theory of simultaneous ignition of fuses in mining operations. The question of how to fire off a great number of fuses at once is of interest to New-Yorkers, as perhaps more than 8000 must be exploded at the same instant when the time comes for the great blow-up at Hell Gate. The essay dealt with the mathematical points involved, discussing by algebraic formulae the factors presented by the number and different characteristics of the fuses, the number of the connections and their characters, the conducting power of the wires, and the electro-motive force of different instruments. From theoretical results thus obtained a rule had been framed and reduced to practice on a large scale by the government. In reply to a question, General Abbot stated that 2500 fuses had been fired at one instant by this method. In respect to machines, the Gramme electro-magnetic machine showed less irregularity in its results than any other. The date for blowing up the Hell Gate rocks this summer had not yet been determined, as it was dependent upon the progress of the mining operations.

I despair of giving an abstract of Professor F. A. P. Barnard's learned exposition of the theory of magic squares.

These, as most readers know, are a series of numbers set in the form of a square, which add up the same sum whether the columns be added perpendicularly, horizontally, or diagonally. In some of these arrangements the rows parallel to the diagonals, which, after running out at top or bottom, are resumed from the point immediately opposite and continued to completion, give also the same sum as the diagonals. The earliest magic squares appear in a manuscript said now to belong to the National Library of France, the work of Emanuel Moschopolus, a Greek of the sixteenth century, which was translated into Latin by the mathematician De la Hire, and read by him before the (French) Academy of Sciences in 1691. Here are some specimens of his work:

FIG. 1.

11	34	7	20	3
4	12	25	8	16
17	5	13	31	9
10	19	1	14	22
22	6	10	2	15

FIG. 2.

1	15	14	4
12	6	7	9
8	10	11	5
13		3	16

In the first of these the common sum is 65; in the second, 34. Out of a great number of curious examples by which Professor Barnard illustrated the algebraic rules and system upon which squares could be made possessing different remarkable properties I shall only select the following:

Even-numbered built-up square.

51	92	54	90	56	83	8	86	60	84	79	72
93	33	110	36	108	38	106	40	104	100	50	58
71	43	19	134	22	122	34	130	117	32	102	74
88	111	37	9	134	12	132	130	18	118	34	63
69	46	135	16	6	140	7	137	139	20	99	78
81	108	30	135	143	1	142	4	10	115	43	64
98	47	119	17	138	8	139	5	138	26	98	77
78	101	31	131	3	141	2	144	14	114	44	67
65	49	116	127	11	133	13	136	29	96	80	
75	97	113	31	128	23	131	25	28	126	48	70
63	95	35	109	37	107	39	105	41	45	11	82
73	53	91	85	89	57	87	59	85	61	66	94

From the above, the central squares, bounded by heavy lines, may be removed one by one, beginning with the middle one, and what is left will still have the properties of a magic square. The principle was carried out also in a magic circle, a magic cyclovolute, a magic cube, a magic cylinder, and finally a magic sphere. It may well be imagined that a discussion of the theory of these puzzles is of necessity abstruse; but if excuse were wanting for wasting time on the study of them, it might be mentioned that one of the most ingenious—the magic circle—was devised by the great teacher of economy of time and money, Benjamin Franklin.

THE MOUND-BUILDERS.

Prof. L. H. Morgan read a paper entitled "A Conjectural Restoration of a Pueblo of the Mound-Builders," with the remark that "a conjecture is sometimes worth the time spent upon it." It is necessary first to consider carefully some practices and usages of the aborigines which were general among them over a wide area. We find that in all parts of America they sometimes constructed what may be called joint-tenement houses. We find these houses occupied by a number of related families. They practised communism in living. The marriage relation was simply pairing. They also followed certain customs, which may be designated as the law of hospitality. The land was owned in common by families and households. Those that had fully reached this method of living have been called Village Indians. Prof. Morgan thinks that the Mound-Builders were probably Village Indians from New-Mexico. Their arts as shown by their implements, their copper tools, their textile and felle fabrics were in advance of the Indian tribes found east of the Mississippi.

We find in Yucatan and Chiapas the highest type of Village Indian life. It declines as we advance northward to Mexico and New-Mexico. It was best adapted to a warm climate. The attempt to transplant this mode of life from the Rio Grande, or the San Juan, first to the Gulf of Mexico, and then northward to the Ohio, must have been a doubtful experiment from the start. Nevertheless, the structures left by the Mound-Builders indicate such an attempt; their earthworks may be regarded as the dwelling-sites of Village Indians. It is certain that if a sensible use for these embankments can be discovered, the mystery about them will be dispelled. The theory that they were built for religious purposes is exceedingly improbable; the magnitude of the work, considering their grade in civilization, indicates that these Indians were laboring for themselves, not for their gods. If a tribe of Village Indians, with their acquired habits of living, emigrated to the Valley of the Ohio, they would find it impossible to construct adobe houses. Some modification of the plan and character of the house would be necessary, because of the difference of climate. They might have used stone, but they did not; no stone houses had been built by the Mexican tribes. They might have made a house of inferior character upon the level ground, like the timber-framed houses of the Minnetons. Lastly, they might have raised embankments of earth and built houses on the summits; and this, it is respectfully submitted, is what they did.

The elevated platform is a feature of the adobe houses of New-Mexico; it appears also in the Yucatan dwellings. Let us regard the high bank on the Scioto River as a pueblo. It is an octagonal inclosure 900 feet square, with an opening at each angle and in the centre of each side. The embankments are 50 feet thick at the base, 10 or 11 feet high, and over 30 feet level on their summits. These, then, were the sites of their houses. There are six of these embankments, each 450 feet long, and one of 900 feet. On the inside, before each opening, there is a mound. If the openings were gateways defended by palisades, the whole structure became a fortress. We have now to suppose that the buildings were of timber, on the summits of the embankments, and uniform with the latter in slope. The walls of the buildings were coated with earth, and probably rose ten or twelve feet above the embankments, thus making a continuous sloping rampart 20 feet

high. This form of house would harmonize with the prevailing architecture of the Village Indians; but a knowledge of the actual shape of the houses, or of their interior arrangements, is not necessary to the hypothesis. The Mandam Indians surround their houses with a wall of split timber, coated with earth. It may be pointed out that such structures on the edge of embankments could not be successfully assailed from without, either by Indian weapons or by fire.

Prof. Morgan exhibited a ground plan for such buildings, showing how they might have been readily constructed, and would perhaps contain from two to three hundred families, on the communal plan, and serving the purposes of their former mode of life. In fact, the mode of life necessarily determined the form of architecture. We need not discuss the uses or contents of the inclosure formed by the embankments. It is not at all improbable that it was the Village garden, or at all events received some tillage. But this mode of life was after all not adapted to the climate, and these emigrants eventually succumbed in the struggle for existence. There is evidence of the better adaptation for such a life in warmer climates, from the fact of the longer continuance of the Village Indians in Mexico, and especially in Central America.

CONFIRMATIONS OF THE THEORY.

The paper of Prof. Morgan was listened to very closely and with evident approbation by the many ethnologists present. Major Powell has long made Indian structures a study. He mentioned that several of his observations indicated that where tribes had made an advance in civilization, their tendency was toward the communal or pueblo form of buildings; this is indicated by the comparative age of the ruins, the most ancient not being inclosed at all, while the latest were surrounded by cliffs or walls. The age is determined chiefly by the thickness of the covering debris. Major Powell is inclined to believe that many of the cliff houses were built for refuge during the Spanish invasion, and such is the tradition among the Indians. Among some of the Uten the land of existence after death is placed beyond the mountains; but among the Pueblos heaven is an architectural affair; it is in the second or third story.

Prof. Marsh heartily approved the conclusions of Prof. Morgan, and brought fresh evidence to support them from an entirely different source. In a long series of comparisons of Indian skulls Prof. Marsh has been much struck by the similarity between those of the Pueblo Indians and of the Mound-Builders. As the shape of the Mound-Builders' skull is very peculiar, the coincidence is a very striking one. Prof. Newberry added a few remarks about the buildings on the table-lands, which he said were possibly 600 or 700 years old, while trees growing over the skeletons of the Mound-Builders had been ingeniously shown by Gen. Harrison to indicate an antiquity of not less than 800 years.

THE CAUSES OF THE GLACIAL EPOCH.

Prof. J. S. Newberry prefaced his paper on the glacial period in the earth's history with an expression of doubt as to whether there were yet sufficient facts known to harmonize conflicting opinion as to the causes which produced the ice-covering. No question remained, however, as to the fact that during that period a climate such as now exists in Greenland extended as far south as Trenton, New-Jersey. There are two classes of theories, one ascribing the ice period to causes originating on the earth, and essentially telluric in their character; the other to cosmical or astronomical changes, such as variations in the earth's position with regard to the sun, alterations in the sun's heat, or a movement of the solar system into colder regions of space. Prof. Newberry proposed to consider the view which might be taken by one whose studies were confined to geology. It is admitted that the distribution of land and water has much to do with climate. Prof. Dana speaks approvingly of the suggestion of Lyell that broad and high lands around the poles would serve to exclude the tropical ocean currents. The latter confined to the warmer parts of earth would throw up vast volumes of vapor, which, condensed by the high lands of the North, would produce the glaciers of the ice-period. But to secure this result the land around the poles must be vast, continuous continents.

Prof. Newberry regarded this theory as open to serious objections. Let us apply our argument to the Tertiary, a period of extreme warmth at the north, when a climate like that of Washington prevailed in Greenland, and in fact all across the continent to Alaska. At that time—that is, in the Tertiary—the land was continuous from Europe to North America. Of this fact the evidence was abundant; no other explanation will account for such geological record as the shape of the floods that border northern seas. The unity of the Tertiary flora in Europe and America is proved by examples so numerous as alone to settle any question. On the other hand we find in the tropics that the Tertiary deposits are everywhere marine; so far as we know, that was for tropical areas a period of entire depression beneath the sea. Hence conditions of elevation and depression like those supposed to produce the glacial epoch prevailed in the Tertiary, while the climatic results were quite the contrary.

The proof that a glacial period existed in the Southern Hemisphere is also supported by irrefragable evidence. But on the other hand, the probability that a great continent continuous from the southern pole was raised above the sea at that epoch seems questionable when we consider the enormous expanse and notable depth of the southern oceans. Still another objection to the theory is to be found in the estimate of the geologists of Sweden, Norway, and Scotland, that the glacial period there was one of a depression of from 600 to 900 feet. Again: the Champlain period in this country furnishes a record that is antagonistic; it is marked by boreal shells, indicating a cold climate, and these deposits are level at New-York, rising to a height of 400 feet at Lake Champlain and 1800 feet above sea level on the shores of Polar Bay. If, however, we throw aside dependence upon telluric causes, almost any one of the astronomical changes would serve for explanation; all that seems necessary is to show cause for reduced temperature.

Prof. Newcomb was called upon by Prof. Henry to discuss the subject from an astronomical point of view, and said that the geological questions were not within his scope, but that he should suppose that the record of the rocks would determine whether the mean latitude of the continent had been below freezing-points. If that be admitted, one of two things seemed evident; either the land at that time was very high, or the solar radiation received by it was below the average. The latter appeared to him no improbable supposition. A very slight alteration in the atmosphere of the sun would abundantly account for such a difference of temperature.

Prof. Hilgard said that he had never viewed with favor those telluric theories which strove to account for the glacial ice by supposing it to result from a precipitation consequent

upon an extra amount of vapor raised from equatorial regions. It appeared to him a strange way to account for an excess of cold by providing an unusual heat. He had carefully estimated the total depth of water all over the globe, and found it about 2½ miles. The late Prof. Agassiz had insisted that the continents had been covered by an ice-cap that reached the summits of lofty mountains; but all the water on the globe if frozen into two great ice-caps by precipitation would not afford such a mass and thickness of ice. Prof. Newberry said that the mistake was in assuming such a height for the ice on the interior of continents.

EOCENE ANIMALS.

Prof. E. D. Cope discoursed on the peculiar characteristics of the fossils of the Eocene period. The paper was principally technical and designed to show that the mammals of that epoch were of low type. An enumeration of the fossil forms discovered in the West and those of Europe showed that several large groups were entirely wanting, such as that which sheep, goats, etc., belong to; also, the carnivorous animals were absent, and the marsupials and edentates. The evidences of low type adduced for the Eocene mammals were their small brains, which Prof. Marsh has very fully described, and the inferior character of their feet; animals highly developed having only one toe, like the horse. From this point of view—that is, the feet—man is a very inferior animal. Prof. Cope's remarks also included a comparison between certain Western fossils and those of the Paris basin, with a view to show identity between some Eocene mammals in the two hemispheres. This is a subject upon which Prof. Marsh has very recently published an erudite essay. The object to be reached by these observations is to fix by means of identical fossils what is called the geological horizon between Europe and America—a sort of base-line from which the relative ages of all neighboring fossil beds can be determined. Prof. Marsh spoke briefly, referring to the interest he felt in the subject, and mentioning incidentally that the beds of the Wasatch group which Prof. Cope had specified were the same as those of the Vermillion Creek series; they lie immediately above the Cretaceous formation, and contain the oldest mammals in this country.—N. Y. Tribune.

TESTING SAFETY-LAMPS.

At a meeting of the Académie des Sciences, M. Daubre stated that in the petroleum mines of Alsace the miners were obliged to test their safety-lamps before going down the pits. This was done in the following manner: At the bottom of an open jar is placed a small quantity of petroleum spirit, the vapor of which, mingling with the air in the jar, forms an explosive mixture. The lamp is plunged into this mixture, and the slightest defect in the lamp is proved by a slight explosion. It is desirable that some such system of testing should be adopted in our collieries.

THE SOUTH.

(See illustration on following page.)

"THE South" is a Restaurant, within the Exhibition grounds conducted by Edward Mercer, of Atlanta, Georgia, in the true Southern style; the building itself is attractive, and has several attractive adjuncts. It is 185 feet by 90, and has 4 large dining-rooms. One of the Southern features is the presence of a band of genuine plantation minstrels, who will illustrate the gay feature of time-past plantation life.

THE U. S. EXECUTIVE DEPARTMENT AND THE GOVERNMENT BUILDING.

No. 7.

THE display to be made by the various departments of the U. S. Government, at the Centennial Exhibition, in the structure known as the Government Building (illustrated on page 308), will differ in a marked degree from that which will be contained in any upon the grounds. These departments, and notably the Army and Navy, have in their possession a large quantity of unique material in the nature of mementoes, curiosities, relics, and specimens relating to their several spheres, as well as papers, documents, maps, charts, and other records, accumulated during the past century, and illustrative of the comparatively primitive ways and means of our ancestors in the arts of peace and war, and governmental matters generally; the most important of which will be brought together in this building for the first time in the history of the country.

In contrast with this will be placed the most improved of the more modern machinery and appliances, as well as illustrations of the most refined of the present methods of practice in the conduct of the departments represented and of the Government. In this way will be presented a picture of the nation's progress in the first century of its existence in all matters pertaining to the internal workings of a republican government, which will prove not only more forcible and instructive than could be reached by a single exposition of our best and latest productions and practice, but it will lend an attractiveness to this collection which will not, I think, be exceeded by any other within the Exhibition inclosure. To compare side by side, for example, the old and, in its day, wonderfully heavy 32-pounder, with its 6-inch bore, and the monster gun now being mounted outside the building, and projecting its gaping muzzle of 20 inches diameter out upon Belmont Avenue; capable of swallowing and belching forth again its 1100 pounds of cast-iron, and weighing, exclusive of its carriage and adjuncts, about 57 tons; or to place the lumbering old methods of carrying the mails by the exercise of the severest strain upon poor, uncomplaining horse-flesh, in contrast with the modern postal railroad-car and lightning train, will exhibit the grand progress made more forcibly by far than could be done by merely presenting the latest improvements in these things; and this feature of the Government exhibition will render it of more than ordinary interest to our own people, as well as to the foreign visitor.

The building, designed by Mr. James H. Windrim, it situated on Belmont Avenue, nearly north of Machinery Hall, and immediately opposite to the Woman's Pavilion. It is 504 feet long, 390 feet wide, and is built in the form of a Greek cross. The nave is 100 feet wide, and in length 448 feet, with an aisle 60 feet wide on either side, and the transept is 380 feet long with the same width, and has similar aisles. At the intersection of the nave and transept is an octagonal dome, surmounted by a lantern, the top of which is 87 feet above the floor of the building. At either side of both ends of nave and transept are located offices, furnished with closets, bath-rooms and all conveniences, for the use of officers who will be in charge of the various branches. The area of floor is nearly 84,000 square feet; and the cost of the structure will be about \$80,000.

There will be a short line of shafting in the wing set apart for the Army exhibit, driven by a pair of Baxter engines and boilers, from which power will be taken for machinery used in the manufacture of cartridges and small fixed ammunition. The management of the building will be vested in a Board of officers, who will severally represent the department opposite their names, as follows:

Col. S. C. LYFORD, War Department, *Chairman*.
Adm'l THORNTON A. JENKINS, Navy Department.
Hon. R. W. TAYLER, Treasury Department.
Hon. JOHN EATON, Interior Department.
Dr. C. F. MACDONALD, Post-Office Department.
WM. SAUNDERS, Esq., Agricultural Department.

with this will be exhibited small arms of all kinds peculiar to naval uses.

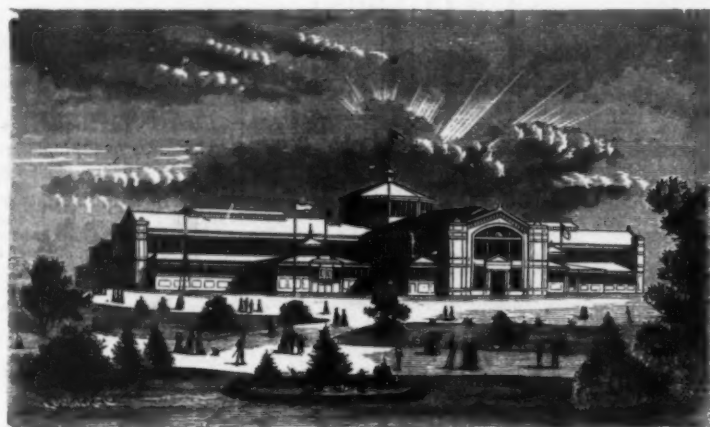
The Engineering, Constructing, Navigation, Seamanship, Pay, and Medical Bureaus will be fully represented, and the working of them shown. The Bureau of Steam-Engineering will make an extensive display of marine steam-engines, boilers, and other accessories of the steam war-vessels which come under its jurisdiction, among which may be noticed a pair of engines of 36" x 48" cylinders, built under the direction of the Bureau, from the designs of its late chief, Benjamin F. Isherwood. These are known as belonging to the "Epervier" class, having been built for a vessel intended to bear that name during the latter days of the rebellion, which, owing to

well as an interesting collection of illustrative material relating to the lugging of a ship and the determination of her direction and rate of progress through the water, including illustrations of the variation of the compass, and the influence of iron ships upon it, with the precautions observed and instruments used to counteract them.

The system of conducting the disbursing of the financial sinews of war, and the methods of feeding, clothing, and otherwise providing for the comfort of "poor Jack," will be fully elaborated in that part coming under the Pay Bureau; while the Bureau of Equipment and Supplies will show the advances made during the last 100 years in the vast paraphernalia of spars, ropes, chains, anchors, blocks, and kindred objects



THE INTERNATIONAL EXHIBITION OF 1876.—THE SOUTH.



THE INTERNATIONAL EXHIBITION OF 1876.—THE UNITED STATES GOVERNMENT BUILDING.

Prof. S. F. BAIRD, Smithsonian Institution, and Commissioner of Food Fishes.

WM. A. DE CAINDRY, *Secretary*.

Col. JOSEPH S. CONRAD, U. S. A., *Dist. Officer*.

Of the articles to be on exhibition, I can do little more than generalize at this time; but the following will serve to convey some idea of what may be looked for when the preparations within and around the building are completed.

In the War Department will be exhibited both the old and new methods of the manufacture of cartridges and small projectiles, cutting and making army clothing, etc., in which processes will be used some very ingenious and expensive machinery. Here will be shown the various kinds of small arms, from the old Revolutionary flint-lock musket and the clumsy horse-pistol to the most improved breech-loader and silver-mounted ivory-stocked seven-shooter of today. The many venerable relics in artillery will be placed in contrast with the present rifled steel guns and the death-dealing Gatling gun. All the improved paraphernalia of field telegraphy and the signal service will be fully displayed, as well as the contrast between the old and most improved means of transportation of men and material, and the victualling, housing, and clothing of an army. The science of aeronautics, so far as it has attained to the dignity of a science, in one of its utilitarian aspects, will be shown in its application to reconnaissance. The use of the torpedo and mine and other surreptitious destructive, and the application of civil engineering to the uncivil occupations of attack and defence, will be completely shown. Illustrations of the peculiarities and progressive phases of American tactics, and, in fact, every thing pertaining to army matters will be exhibited and subjected to the scrutiny and criticism of the world, except of course that which the commonest dictates of prudence requires to be kept secret.

The Navy Department, imbued as its personnel is with Jack Tar's predilection for the "curio," which is more or less an outgrowth of his wandering habits, and meeting the opportunity to collect and accumulate all kinds of curiosities and relics in his excursions to "the ends of the earth," will be foremost in its exposition of this kind of material; and its collection of curious and ancient objects will be, too, of a more cosmopolitan character than that of the Army. No one who has paid a visit to the state-room of a naval officer, or even examined the "ditty-box" of Jack himself, upon his return from some foreign cruise, but has had the conviction that this accumulation of rarities and curious objects from abroad amounts to a passion with him. Coming in contact, too, and meeting opportunities to become acquainted with the peculiarities of the naval establishments of other countries, it is his delight to compare them with his own, wherever the latter appears to him in a superior light—as when does it not to the lineal descendant of positive and sanguineous old John Bull? There may, therefore, be contrasted in this wing of the building not only objects the result of the progressive steps made in our own country in naval matters, but, to some extent, the world's progress in them will be exemplified.

In the matter of weight and destructive power of naval ordnance and projectiles, and the contemporaneous advances made in the means and methods of resisting them by the armoring of ships of war, there will be extensive preparations made for fully illustrating its every feature. Nearly all the varieties of shot and shell ever seen or heard of will be seen here, either in the objects themselves, or as illustrations by model and diagram; and the same will be true of the guns in which they are used. A wooden *fac-simile* of a turret of one of the monitors of the Miantonomah class, of 11 inches thickness of armor, and, when of iron, weighing, including the two 15-inch guns within it, about 350 tons, will be erected just outside the building, and specimens of the many kinds of armor-plating now in use will be shown. In conjunction

with this will be exhibited small arms of all kinds peculiar to naval uses. The Engineering, Constructing, Navigation, Seamanship, Pay, and Medical Bureaus will be fully represented, and the working of them shown. The Bureau of Steam-Engineering will make an extensive display of marine steam-engines, boilers, and other accessories of the steam war-vessels which come under its jurisdiction, among which may be noticed a pair of engines of 36" x 48" cylinders, built under the direction of the Bureau, from the designs of its late chief, Benjamin F. Isherwood. These are known as belonging to the "Epervier" class, having been built for a vessel intended to bear that name during the latter days of the rebellion, which, owing to

incidental to the war-vessel. The Medical Bureau will exhibit to us, perhaps, how much better and easier the operation of extracting an injured member may be performed than when a knife, a saw and a bucket of hot tar were all the scientific instruments thought necessary for the amputation of a poor fellow's leg. They will also show us how the health of the jolly tars is preserved under the somewhat abnormal and artificial mode of living inseparable from a seafaring life; and perhaps the good doctors will explain to us the experience of the past twelve or thirteen years in the effect upon the sailors of the deprivation of the previously time-honored whiskey ration, and whether the traditional jollity of Jack has been sustained under it. In the department of Seamanship there will be a large number of models and illustrations peculiar to it, which will, perhaps, more than any other branch, interest the lay, rather than the professional visitor.

The complicated and perfect system of conducting the Treasury Department, and the methods of checks and balances by means of which the vast sums of money flowing to and from government hands are daily accounted for, as well as the management of the Customs and Internal Revenue Bureaus, in all their extent and completeness, will be shown. Not the least interesting part of the exhibit made by this department will be in the specimens of ingenious machinery and apparatus used in, and the processes of, engraving and printing paper-money, stamps, etc., together with the means taken to render fraud in the manufacture and subsequent counterfeiting of these notes and stamps impossible. Then there will be an exhibition, under the Smithsonian Institution, of mineralogy in its application to the extraction from the earth, and subsequent manipulation, of the ores of the useful and precious metals; and for this purpose it will illustrate the use of giant-powder and other explosives, with a section of a mine showing the shafts, drifts, etc., and in conjunction with these will exhibit a collection of specimens from the "Big Bonanza," Ophir, and other celebrated mines.

Under the Agricultural Department will be exhibited all that pertains to its management, which, in this country of immense and varied agricultural production, will be a source of much interest to our foreign visitors.

Under Prof. Baird, of the Smithsonian, will be shown the advances made during the past few years in the propagation and management of the growth and development of food-fishes, with the methods of stocking rivers, lakes, and ponds therewith; the only branch of the Exhibition to be made in this building, perhaps, in which there will be no well-defined ancient landmarks from which to date a departure.

I think that nothing is hazarded in saying that when the preparations going on in and about this building are completed, it will be one of the most attractive and interesting of any of the branches of the Centennial Exhibition.

J. T. H.

THE CENTENNIAL PHOTOGRAPH COMPANY.

The Company is an organization of practical photographers from all parts of the country and from the Canadian Dominion; they have the exclusive control of the taking and selling of photographs within the grounds. They have erected a unique model studio; the panels, or *band windows*, shown in the front and sides, are filled with handsome specimens of the art, ornamented by being framed in living vines trained and festooned about them, forming a beautiful panorama. Edward L. Wilson, Editor of the Philadelphia Photographer, is the Treasurer and General Superintendent, and John A. Fraser, of Toronto, is the Art Superintendent, of the Company.



THE INTERNATIONAL EXHIBITION OF 1876.—STUDIO OF THE CENTENNIAL PHOTOGRAPH CO.

power, just completed, from designs of Wm. W. Wood, the present chief of the Bureau, by Wm. Wright & Co., of Newburg, N. Y. They are intended to be placed, at the close of the Exhibition, in the war-steamer Nipsic, now in process of reconstruction at the Washington Navy-Yard. There will also be several pairs of engines for steam-launches, the steam machinery of the torpedo-boat Spuyten Duyvil, and three high-pressure boilers of the most approved design for use with the compound engines, and a large variety of the minor adjuncts of the steam department of a man-of-war, among which will be a new fresh-water distilling apparatus, the invention of Past Assistant Engineer Geo. W. Baird, of this Bureau.

The Bureau of Construction will make an exceedingly fine display of models and drawings, in illustration of the progress made in the direction of marine architecture, from the early days of the Republic to the present time.

The Navigation Bureau will exhibit, erected outside the building, the principal instruments used by our Government in the observations of the late transit of Venus, upon which important and rare occurrence so much money and time has been expended by nearly all the civilized nations of the earth, as well as a most complete collection of instruments illustrative of the mathematics of the determination of the ship's position at sea, and all the auxiliaries to the solution of the problems incidental to that branch of the profession, as



THE INTERNATIONAL EXHIBITION OF 1876.—THE CARRIAGE EXHIBITION BUILDING

THE BRITISH GOVERNMENT BUILDING AT THE EXHIBITION.

IN OUR SUPPLEMENT No. 1, we gave the architect's elevations of these buildings and the ground plans thereof. We now present views, showing their appearance as actually erected upon the grounds. It will be observed that they represent the picturesque half-timbered style of the sixteenth century; the roofs are covered with red tiles and present a very striking appearance. The buildings are admirably finished and substantially furnished. The building at the right contains the offices of the British and Canadian Commission, that in the centre is the residence of the attaches of the British Commission.

THE CARRIAGE EXHIBITION BUILDING AT THE CENTENNIAL EXPOSITION.

THE position of the building is north of the Main Building and west of the Art Gallery, on the main avenue leading from the Art Gallery to Machinery Hall, Government and other buildings. It is also near Belmont avenue, the principal drive through the grounds.

The building is 346 feet long, 231 feet wide; in shape, a parallelogram. The material used in its construction is wood, sheathed with corrugated iron. The building is one story high, with hipped roof, having five skylights running the full length of the building. From the floor to top of roof is 36 feet, to main plate, 24 feet. Four principal entrances allow

of the easy ingress or egress to and from the building. Besides the skylight, the building has large windows, 14 feet in height, on the side. Offices are placed at each entrance of the building, affording accommodation to the many visitors.

The south half of the building is allotted for the carriage trade; the other half to palace cars and stoves.

The amount of square feet allotted to the foreign countries and Canada, is as follows: Great Britain, 4,500; Germany, 210; Italy, 224; Canada, 2,700.

There will be about 75 exhibitors of carriages from France who will probably exhibit in the United States. Wagons and omnibuses will be placed in the Agricultural Building.

ARE THE JAPANESE SLOW WORKMEN?

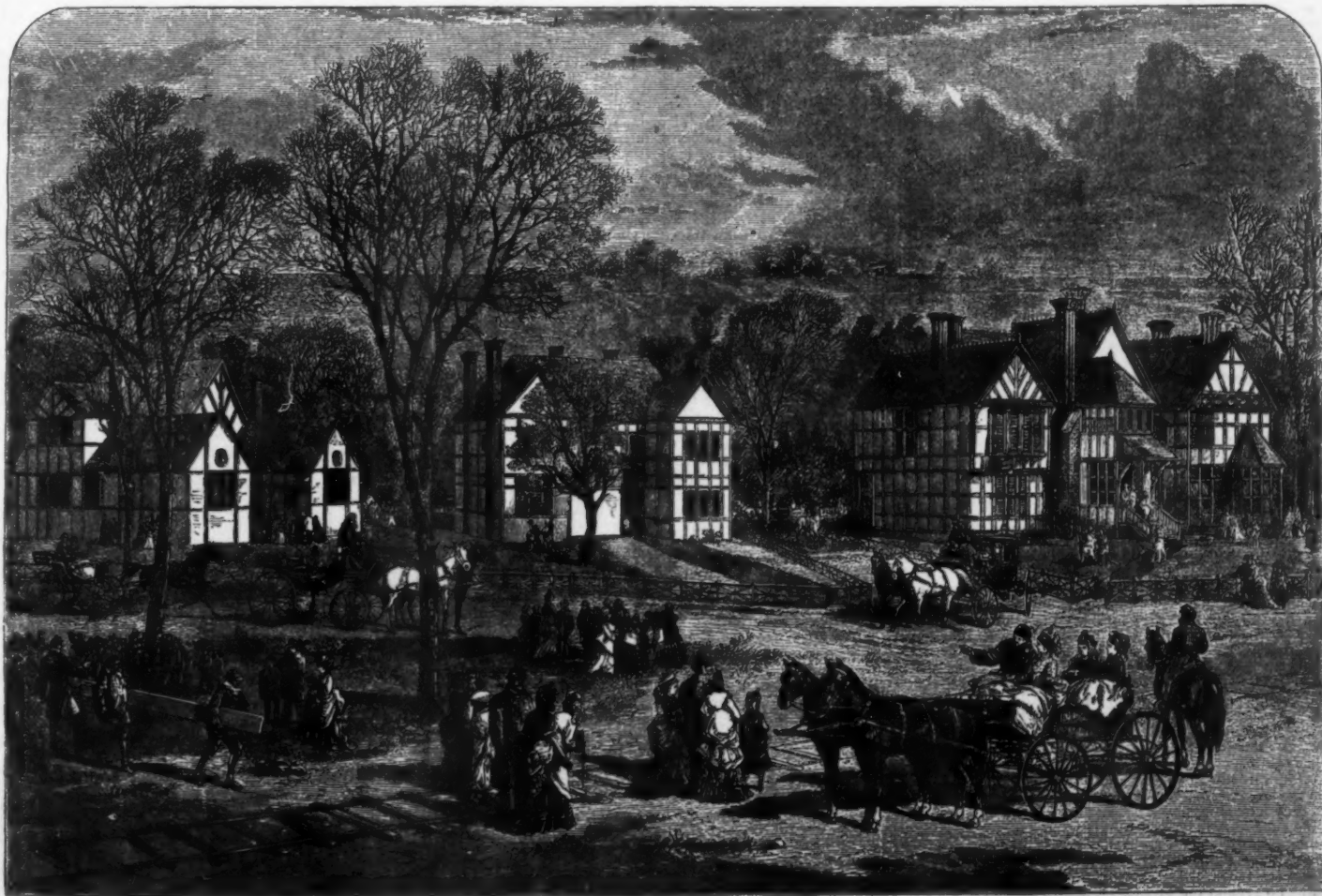
THE opinion that the Japanese in Fairmount Park are but indifferent workmen in point of speed is very generally promulgated by Centennial correspondents; they dwell upon the wonders and chagrin that the poor follower of Confucius must feel at being completely hedged in by his Christian contemporaries. They speak jestingly of his slow motions and quaint ways, and patronizingly of the knowledge of his trade that he will acquire by observation.

This conclusion is the first to strike a casual observer if, standing at a distance, he takes in the respective adornments of the buildings back of the Machinery Hall. He sees the New-York Pavilion, with its many rows of scroll-work, its

delicate mouldings, and parti-colored paints; the English manor-houses, resplendent in white plaster and slate-work; the Jersey State edifice with its high steeple—any of which, it would seem, should take twice the time to erect than should the little house of the Japs. He knows that these were completed in an incredibly short time, while the latter is still in course of erection, and he brands the half-civilized workmen as slow without compunction.

But if he will approach and observe the work they have done and are doing, he will learn that their building equals in finish the finest piece of cabinet-work that has ever been produced in this country; and will himself be struck with admiration at the artistic skill displayed by them. No one can possibly know (unless he has been constantly upon the ground) the actual amount of work put upon this modest-looking structure. Each piece of timber, no matter for what use intended, is as carefully prepared as is the stuff from which an American is about to frame a door.

I observed a Japanese planing up a piece from the rough. Instead of the jack and smooth (the uses of which are unknown), he used a clumsy little tool with the iron reversed, so that the motion was towards him. One end of the stuff rested upon a trestle waist-high, the other upon the ground. He stood upright at the elevated end, and with a series of quick jerks and backward jumps reached the lower, stooping as the timber inclined until he had doubled himself up like an acrobat. A shaving the whole length was the result. This was repeated two or three times; the iron was then



THE INTERNATIONAL EXHIBITION OF 1876.—THE BRITISH GOVERNMENT BUILDINGS

knocked out, the stone resorted to, and the edge carefully restored. This alternate planing and sharpening was continued until he was satisfied with his work. I looked at my watch and found that fifty minutes had been consumed over a 30-foot timber 3 x 4, the work of ten minutes to an American. This would have disgusted me at once with the Celestial, had I not inspected his work. At no place along the whole length could be found the slightest deviation from the right angle, nor could a ray of light be seen under the square. There was not a scratch or dent upon it to tell that the plane had been used, the edges were as sharp and regular as those of a well-finished marble slate, and its whole appearance led me to the belief that it was intended to form part of a door-jamb, or some part of the work that would be constantly under critical eyes. And yet that beautiful piece of work was intended for use in a place where it could not possibly be seen, and is at this time as much hidden as a piece of studding in the British Building.

This is a fair example of their manner of constructing Exhibition buildings. When we consider that they work with a back-saw the blade of which (if more than six inches long) is in two or more pieces, a hatchet that resembles nothing in civilized use, a plane the iron and tote of which are backward and the general appearance clumsy and unhandy, we can not help feeling respect for these finished workmen, and admiration at the progress they have made towards the completion of their beautiful little cabinet.

LAVAN.

LESSONS IN MECHANICAL DRAWING.

By PROF. MACCORD, Stevens Institute.

(Continued from page 278. See Illustrations on page 316.)

No. X.

FOR the purpose of acquiring skill in the handling of the compasses, and habits of care in the execution of work at every step as well as in the final processes, no practice is better than that afforded by exercises in which a number of circles are to be drawn within a given figure, tangent to it and to each other. But the "laying out"—or, as we shall in future call it, the construction—of such exercises involves the application of one or two geometrical problems, which we shall therefore explain first.

And this leads us again to allude to the distinction between mechanical and geometrical drawing. This distinction, so far as any exists, is based upon this consideration: that in the former we depend for the accuracy of parallel and perpendicular lines upon that of our instruments. For example: if it be required to draw through a given point a line either parallel or perpendicular to a given line, we do it by means of the triangles, in the manner shown in Figs. 9 and 10; and if the instruments are true to begin with, the result will be as perfect as if we had done the work by geometrical processes.

We wish here most emphatically to protest against the heresy which many impute, that the degree of accuracy aimed at in mechanical drawing is never equal to that supposed to be required in geometrical drawing so called. It is very true that in many cases the purpose for which a drawing is made is such that it is not necessary that it should be extremely accurate. But in many other cases it is necessary that the work should be done with the greatest precision; and he who in any way gets the notion in his head that in drawing mechanically he is not expected to draw accurately, will do well to get it out again as speedily as possible. The simple truth is that mechanical drawing is geometrical drawing, and in the execution of what goes by the latter name, including the plotting of maps and the like, we are as much at the mercy of instrument-makers as in any thing else: the laying down of an angle of twenty-two and a half degrees with a protractor is as purely mechanical an operation as drawing a perpendicular with a triangle, and a defective instrument will do as much damage in one case as in the other.

What is most important is that one should be able to judge correctly of the degree of accuracy which is necessary in any case that may arise, and be able to do the work with that degree; and in order to make sure of that, the best way is at the outset to aim high—to do the work as perfectly as the means at hand will permit. It will be found that as greater progress is made and greater facility acquired in the handling of the instruments, it will be as easy to make a drawing with a high degree of precision as it would have been to do it in a far inferior manner had the opposite course been pursued. By the opposite course we mean that into which too many fall, of hurrying through with a task in a careless way, excusing their inaccurate work by saying that "it is not worth while to take much pains with that, and it would take so much time"—reserving their painstaking for more important tasks—and too often finding that their confirmed habits of disregarding little things have rendered it difficult, if not impossible, to execute those tasks satisfactorily when they come to them.

Now, the processes of construction in mechanical drawing are all based on geometrical truths, whether we make use of instruments for performing parts of them, without going through the steps of the reasoning involved, or not; and, as we remarked in the introduction, a knowledge of geometry is of the greatest use to one who intends to make use of his skill in drawing in application to mechanical devices, which we repeat again for the benefit of those of our readers who may have that design, and earnestly recommend them to acquire that knowledge, which they can do with diligence, without a master.

The bisection of an angle is an elementary geometrical problem which is involved in so many operations which a draftsman must necessarily perform that, simple as it is, we call special attention to it. And this for one reason in particular—that we have seen many who, knowing perfectly well the principle, seem to think that it makes no difference how it is done. To illustrate our meaning: in Fig. 101 we wish to bisect the angle at A; in order to do this we take A as a centre, and with any radius, as A B, we describe an arc, cutting the lines including the angle at B and C; then with the same or any other radius we describe two arcs with B and C as centres, cutting each other at D or E, and finally draw a line through this intersection and the vertex A, which bisects the angle. Now we have seen this done with a radius A B of only an inch or two long, and the intersection made at D with a shorter radius; and on criticising that work, have been met with the logical reply that it was all right because it was strictly in accordance with geometrical reasoning. This is very true; and were our appliances perfect, there would be no ground for finding fault. But they are not perfect by a great deal; and this simplest of constructions has been selected for the reason that it illustrates most clearly one or two points of great practical importance in reference

to the means of reducing to the minimum the errors due to such imperfections in the instruments and in their handling.

To begin with: If we imagine the chord B C to be drawn, it will appear that our operation depends upon the bisection by a perpendicular of this line B C; and in doing that there is as much chance of making a certain error if it be short as if it be long. Clearly, then, it is better that B C, and therefore A B, should be as long as we can conveniently make it. Again, having made it so, why should not D be as reliable a point as E? The difference depends on this: that there is a liability to make an error in the location of either point, which must be done by means of the intersecting arcs; this liability is as great in one case as in the other. If then we choose D, it will be seen that any error will be increased as we prolong the bisecting line from the vertex of the angle. Not the error in direction—for that will remain the same—but the error as measured from any point; as, for instance, B or C on either line. But the error in direction, it must be observed, will be much greater if we select D than if we choose E, if the errors in locating these points be of the same magnitude; for if we draw arcs through them, the one through E will be as many times longer than the other as A E is longer than A D; so that a minute error will be a larger fraction of the shorter arc. And still, again, we were at liberty to use any radius for the arcs by whose intersection D or E is determined, provided they were long enough to cut each other at all. Theoretically, then, according to the common usage of the term, one radius is as good as another; practically it is a great deal better, for another reason: these arcs, as we draw them, have some thickness, and if they intersect each other acutely, the effect produced is that shown, on a greatly enlarged scale, in Fig. 102 at M. The actual point of which we are in search is the centre of an elongated lozenge, and it is by no means as easy to determine by the eye just where it is as if the lines intersected at right angles, as at N, thus leaving us to determine only the centre of a square.

We have been thus full in relation to this operation not only because it is one of the most common and one of the best-based constructions to be met with, but because it forces upon our notice the cardinal maxims to which we alluded above—which are: First, in locating points which determine a right line, let them be placed as far apart as possible (as A and E in Fig. 101). Second, in determining points by the intersection of lines, let these lines cut each other as nearly at right angles as possible. In many cases, of course, the construction is limited or trammelled by the conditions of the problem, but in a great many others the operator is left to exercise his own judgment within a much wider range. In the problem mentioned, for instance, it is possible always to extend the sides of the angle at least to the edge of the paper, and often much farther; and when the best results are desired, this should be done. And a very good plan also is, if possible, to extend them in the opposite direction, as indicated in the dotted lines A F, A G, and to make another intersection, H, as if to bisect the angle F A G; then H E should pass through A.

We repeat here what we have often said, that it is better to leave out a line than to rub it out; and in this operation it need hardly be said that the arc B C need not be drawn: it is only necessary to mark the points B and C. This is better done with the pencil-compass than with the dividers; in fact, the latter should be used as little as may be, and never under any circumstances should an arc be drawn with them, as it scratches the paper, and at best it is not as easy to see a mark of that kind as one in pencil.

Though it is not our intention to introduce the drawing of geometrical problems, as such, as exercises for practice in line-drawing, it will be necessary occasionally to give them in explanation of other things. In no particular would the advantage of acquaintance with them be more striking, perhaps, than in the facilities that would be given by it for testing or checking work. Not only by comparing the result of a mechanical process with that of a geometrical one, although that is a good method, but it often happens that there are different geometrical constructions, in which case if there be any doubt one may be compared with another; and again, certain results, perhaps, ought to follow from a certain construction, and a knowledge of geometry is a great aid in leading to the detection of errors, if any exist, by means of such examinations. Of all the elementary truths in that science, perhaps none is more fruitful in its application in drawing than this: that every angle inscribed in a semicircle is a right angle; thus in Fig. 103, A B is the diameter of the semicircle, and the angles at D, E, F are all right angles—a relation easily remembered from its very simplicity, and one which the student of ordinary ingenuity, even if ignorant of the reason why it is so, will be able to make very useful in his constructions and in devising checks.

Fig. 104 is an exercise of the kind mentioned at the beginning of this lesson: within the larger circle, whose centre is O, there are to be drawn three circles tangent to it and to each other. Let A B be one sixth of the circumference, and A F also one sixth; then proceed as follows: Draw a tangent at A and the radius A O; draw O B, and produce it to cut the tangent in G; bisect the angle A G O by a line which will cut A O in L, the centre of a circle which with radius A L will be tangent to O F, O B, and A G; and as B O F is one third of the circle, it follows that the centres of the other two circles will be equidistant from L and lie on a circle whose radius is O L and centre O, as shown at M and N.

These steps, it will be observed, are few and simple, yet each one affects the following one, so that any error is more likely to grow worse instead of better as we proceed; and the novice will find that it requires very careful manipulation of the instruments to make the three circles truly tangent to each other. The least inaccuracy in the radius or the position of the centre of either of the circles involved in the construction, or of the ones which are finally to be drawn in, will give rise to a sensible error; which leads us also to remark that it is best to do as much as possible with a pair of compasses, when adjusted, at once; time is thus saved, which is itself of importance; but, more than that, we are sure of having the radius unchanged, while in readjusting it there is always a chance that we shall not set the compasses precisely right. In the present instance the student is advised to proceed as follows: Draw first the vertical line through O, the selected centre of the larger circle, then adjust the compasses to the desired radius O A, and having drawn the circle, set the needle-point at A, and mark off B and F on the circumference; also from D mark off C and E, with the same radius, and then, before laying down the instrument, set the needle-point at B and describe the dotted semicircle through O A G. The lead in the compass should be hard and trimmed to the finest working edge, and the circles made clean and sharp. The semicircle last mentioned may be drawn either in a very fine, full line or, better, broken, that in inking in it may not be drawn full by mistake; the eye can judge nearly enough where O B will cut it, and it should be carried a little beyond that point, being in fact rather more than a full semicircle.

Next draw E B, which should of course pass through O, and prolong it till it cuts the semicircle in G; at the same time prolong it in the opposite direction towards I, as far as the limits of the paper will allow. If now we draw G A, it will be tangent at A to the circle first drawn; for O B is the diameter of the semicircle in which the angle O A G is inscribed. This tangent should also be prolonged beyond A as far as possible, and G H set off equal to G I; from H and I describe two arcs with the same radius, intersecting at K, and draw K L G to determine L, taking care to have the arcs cut each other at right angles as nearly as possible, as before described. By observing this order of proceeding we incur the least chance of error, since the principal circles and measurements with the compasses which are made with the same radius are drawn and set off without laying the instrument down—a point to which we again call attention as uniting speed with accuracy. Having determined L, we describe a circle about O with radius O L, cutting E B in M and F C in N, the centres of the two remaining circles.

As a companion to this we give in Fig. 105 another exercise of the same kind, in which it is required to inscribe in a similar manner three circles in an equilateral triangle. The construction is exceedingly simple: A B C being the triangle, draw a perpendicular from each angle to the side opposite, as C D, A E, B F; from D, for instance, set off on the perpendicular C D a distance D G equal to A D the half of A B (this is indicated by the dotted semicircle, which should pass through E and F). The point G thus found is the centre of one of the required circles, whose radius is found by drawing G H perpendicular to B C. Otherwise G might have been found by bisecting the angle A E C, as indicated by the dotted line E I, which also cuts C D in G—which affords an illustration of the mode of checking a construction by determining a point in two different ways.

For continued practice in straight-line work we give in Figs. 106, 107, 108 some snow-flake figures of more complicated construction than those previously presented—in regard to which, however, it is not necessary to give any detailed instructions—and in Fig. 109 a simple design for inlaid work such as is often met with in ornamented boxes and the like, effects which can not be reproduced in an engraving in black lines, being produced by the contrasting colors of various kinds of wood. But the design is easily laid out, and, though it requires no description, will afford very useful and agreeable practice to any one who will exercise due care and taste in producing the contrasts of tint or tone by means of line-shading with the pen or, for that matter, with the pencil. If the paper be clean and smooth, and the pencil kept trimmed so as to make sharp, crisp lines, very pleasing effects may be produced with it; indeed, in such work as this a combination—the shading of part with the pen and part with the pencil,—will sometimes enable us to produce even more satisfactory contrasts than the exclusive use of either.

(To be continued.)

BRIDGE PIERS.

By W. SOOY SMITH, C.E., Booneville, Missouri.

WHILE building the bridge across the Missouri River at Booneville, it became necessary to construct the pivot-pier of the draw-span, and the one next south of it, upon a slightly undulating rock bottom, in fifteen feet of water at ordinary stage. The inequality of the surface of the bottom amounted to about two feet from the highest to the lowest point occupied by the pivot pier. Beneath the other pier it was less. During low-water the current was quite gentle, not exceeding two and one half miles per hour; and when the current had this low velocity there was a deposit of sand upon the bottom sometimes reaching the depth of two feet. During freshets the current sometimes reached six miles per hour, and then the rock was swept bare.

To make a water-tight coffer-dam in the ordinary way upon a rock bottom in water fifteen feet deep would have been very difficult. To prepare the bottom to receive the masonry laid in the old-fashioned caisson way would have been very expensive. The following plan was therefore adopted:

The exact outline of each of the piers was described on the ice while the river was frozen over, and an accurate sounding was taken every two feet on this ground plan.

A crib eight feet in height was then framed consisting of 12' x 13' timbers put together and thoroughly drift-bolted. The bottom of the crib was made to fit the rock upon which it was to rest. The inside space was divided into compartments, about eight feet square each, by partition-walls consisting of 12' x 12' timbers well drift-bolted. These partition-walls were only carried down to a level two feet above the bottoms of the exterior walls, to allow for any inequalities that might exist in the surface of the rock, upon which a partition-wall might otherwise have rested before the crib had reached its proper position and bearing.

When so far completed, the crib was towed into the stream and moved nearly into position by means of anchorages surmounted by a strong framework caulked and forming a water-tight coffer-dam, which should rise a sufficient height above water when the crib rested on the bottom to prevent an overflow by the sudden rise in the river.

A platform rested on the framework of the coffer-dam, upon which stone was deposited to load and sink the crib. This stone was afterward used in the construction of the pier, and so the loading of the crib required no expense for labor or materials. As the stone was placed upon the platform and the crib sunk, just as the structure began to rest upon the bottom, it was carefully pulled into the exact position it was to occupy, and held there until it was thoroughly grounded. The crib was so designed as to project beyond the pier at its base two feet all around, except on the up-stream side, where its pointed end extended fourteen feet beyond the masonry.

The first attempt at sinking the pivot pier was made during the winter-time, when the river was low and the current so gentle that there was a deposit of sand upon the rock two feet in depth. This deposit was soon cut from under the up-stream end of the crib by the increased scour of the current produced, and an increased thickness of sand was deposited in the centre, and at the down-stream end of the structure, causing it to tip toward the up-river side at a considerable angle.

This was anticipated and, we thought, provided for. We had a powerful rotary pump and a six-inch steam-syphon in readiness, and with these we undertook to remove the sand from beneath the crib. We did remove perhaps three times the quantity that existed there when we commenced pumping, but it was replaced by other sands brought in by the current as fast as we could remove it. We then attempted to wash away the sand by means of water-jets, and with these we could remove the sand rapidly, but only over an area too limited to prevent our crib to sink. The river was frozen over during these operations, the ice being about one foot in thickness, blue and solid. The temperature then rose, as did the river also. The ice was broken loose from the shores, and came

down the river in fields extending from shore to shore and from bend to bend in the river. This ice carried away all the upper framing of the coffer-dam and the platform holding the ballast or loading of the crib, and the latter, relieved of its load, rose and floated a mile and a half down stream, where it lodged on a sand-bar. Here it was taken apart with extreme difficulty and brought back to the bridge site and put together again.

Profiting by this experience, we got every thing in readiness, and waited the arrival of the spring freshets to lay the rock bare. When these came we again moved our crib into position, and sunk it upon the bare rock without difficulty. We then threw in small stones to the depth of about one foot around the outer wall of the crib, inside and outside, to prevent the wash of a current under the bottom.

The compartments of the crib were next filled with first-class concrete consisting of the spawls from our stone-yard, broken so as pass through a three-inch ring, and hydraulic mortar made of one part of the best Utica cement to two parts of sharp sand.

This concrete was laid under water by means of a spout or tremie sixteen feet long and 16" x 16" on the inside at bottom and two inches smaller each way at the top. It was made of two-inch plank strengthened by cleats 2" x 4" every two feet, with smooth planed surface on the inside, and surmounted by hopper, into which the concrete was thrown with shovels.

Three gangs of men mixed cement in as many different boxes, and it was thrown from each box as soon as mixed in the tremie, through which it descended to the bottom.

At the commencement of the operation the tremie, suspended so as to be easily handled, was lowered upon the bottom and held there until it was quickly and completely filled. It was then raised slightly to permit the concrete to escape at the bottom. As soon as it commenced to do so, the work of filling at the top was resumed and the tremie so controlled as to keep the concrete flowing steadily as it was supplied. In this way we prevented the setting of the material in the tremie, and by moving this slowly at the bottom we distributed the concrete evenly and without causing it to fall through the water and separate the mortar from the stones.

Having filled all the compartments of the crib to within one foot of the top, the concrete was permitted to remain undisturbed for ten days to give it time to set thoroughly.

At the expiration of this time the water was pumped out of the coffer dam and the top surface of the concrete levelled and carefully prepared to receive the masonry. The concrete was found so hard that it was with difficulty that it could be removed with a pick, and the bottom of the coffer-dam was made water-tight by it, proving that it was of excellent quality at all points; for if there had been defects anywhere, the water, with the pressure of seven to eight feet head, would have found them.

The concrete having been nicely tested, the masonry was commenced upon it and soon carried above high-water surface. The upper work of the coffer-dam was then used for the base of the scaffolding employed in the construction of the pier, and only removed when it was completed.

We had thus a pier of first-class masonry resting upon a concrete foundation, inclosed in solid walls of timber twelve inches thick, thoroughly drift-bolted, and tied through and through by the cross-walls, which were framed into the outer wall with dovetail joints and secured to them by drift-bolts. The timber-work of this foundation is always under water and below the destructive action of ice. Its strength is greater and its band stronger than that of masonry—it is equally durable, and the filling of such compartment is a monolith—and all these huge stones are united by the common base of concrete two feet in thickness upon which they rest, and by the wooden walls which inclose them.

The second pier, built in this same way, was put in without the slightest accident or difficulty.—*Engineering News.*

THE FERROUX ROCK-DRILL AND AIR-COM PRESSOR.

By H. W. PENDRED, C.E., London.

THE two tunnels respectively known to the world as the Mont Cenis and the St. Gothard, represent two of the grandest feats of modern engineering. The history of that penetrating Mont Cenis, and the leading events attending its formation, are too generally familiar for the author to dwell now upon them; but he will say a word or two of preface as to the St. Gothard Tunnel, where the machine which he is about to describe has earned its renown. Of seven tenders for the contract, five were quickly dismissed for various reasons, the competition remaining between the Italian Company of Public Works and Mons. Favre; the choice fell to the latter, because the Italian company required nine years to construct the tunnel, while M. Favre wanted but eight; besides this, the former only consented to forfeit the caution-money (800,000 frs.) required by the company after the term of eleven years, while M. Favre agreed to forfeit at the end of nine years. The material encountered at Goeschenen end was chiefly hard granite gneiss, at first full of fissures and cracks, but afterwards it was more homogeneous. The two tunnels at Mont Cenis and St. Gothard are not only remarkable as triumphs of engineering science in themselves, but they are also distinguished above all other similar works from the stimulus which their construction gave to the improvement and development of rock-drilling machinery—a branch of mechanism that deserved much more attention than it had received previously, for such labor-saving machines must ever be of great value in countries possessing any share of mineral wealth. The Mont Cenis Tunnel formed the greatest trial-ground ever brought to the attention of inventors and makers of either rock-drills or air-compressors, and now St. Gothard is testing and condensing the experience gained at its older companion. It may fairly be said that at both tunnels every known example of rock-drill has been tried, the principal and most successful being the "Ferroux," the McKean, the Sommeiller, and the Dubois François.

The weak point in all such machines is the feeding-arrangement; but the Ferroux machine overcomes this difficulty effectually. The feed in this machine is on the allotment principle—a certain piece of work is fed to the borer at once, and until this is perforated no more is given; if the borer perform the work in ten minutes, at the end thereof it gets another allotment; while if a hard vein is met with taking (say) an hour to pierce, the borer will get no more till this be done, thus neither under nor over feeding can take place. Referring to the diagram, it was explained that the Ferroux borer consists of two cylinders, set end to end and fitted with piston-rods, and a frame in the machine for tunnels, while, in the machine for mines and shaft-sinking, etc., the cylinders are set side by side one above the other. The one is called the propelling-cylinder, and the other the boring cylinder; the propeller feeds the borer up to its work. The compressed air is introduced into the machine through a coil and enters the

first cylinder, which is the propeller-cylinder; in this is placed a piston fixed on a tubular rod, the other end of which is securely fixed to the boring-cylinder, in which reciprocates another piston and the boring-rod. The compressed air entering at the coil produces three actions: first, it presses before it in a continuous manner the boring-cylinder towards the rock to be perforated, and when the borer has pierced the rock to a depth equal to the pitch of a tooth respectively, in a pair of racks fitted to the upper part, the boring-rod, by means of a collar affixed on it, raises a forked lever, which is provided with a pair of projections acting as pawls on the racks fixed, and the borer is urged forward a distance equal to one notch of the rack. The boring cylinder is thus as it were consolidated with the action of the borer, but it is necessary that it should be also in a sense opposed to it; it is therefore provided with two small cylinders arranged horizontally; in each of these works a piston, so formed on its outer side as to act as a pawl, which engages in the teeth of the rack formed on the inner face of each of the frame-bars. It will be seen that the action of these pawls is the reverse of those regulating the forward movement of the propeller, and they operate to prevent any greater degree of recoil on the part of the borer upon the propeller than the pitch of a tooth in the racks, so that while such pitch admits of an elastic cushion to soften the recoil action and prevent fracture, at the same time the play is too limited to vitiate the boring-action. As the pistons in the small cylinders are subject to the action of the compressed air, they are thus kept forced into the ratchet-teeth, while their oblique leading faces prevent them obstructing the feed movement.

The second action of the compressed air is to operate through a hollow rod, and supply power to actuate the boring-piston in the cylinder. The air enters a valve-box, and is alternately admitted before and behind the piston by the slide-valve in the box. The third action of the compressed air is to actuate an air-engine at the rear of the propeller-cylinder. This engine is constituted of a cylinder within which works a piston with a trunk-rod, over which is a crank and shaft united to the piston by a connecting-rod. The crank is a slotted one, having on the one side an eccentric to shift the slide-valve for its own cylinder, and at the other side a socket-sleeve into which the end of the long shaft is fixed. Beyond the bracket supporting this end of the shaft is a fly-wheel of exceedingly small diameter, so as to economize room for the headings, but wide enough to secure weight sufficient for steady working. The shaft is prolonged and supported in another bracket at the boring-bar end of the machine, and beyond it is an eccentric which actuates a reciprocating ratchet which engages in the ratchet-wheel on the boring-bar, giving it an intermittent rotary movement of one tooth pitch at each blow dealt by the tool upon the rock. To withdraw the tool from its work it is only necessary to close one cock and open another, when the air which pushed the machine forward escapes, and the compressed air passing through goes along the pipe to the front side of the piston and forces it back, which withdraws the tool and closes up the machine like a telescope. A socket serves to fix it to any supporting machine. The propelling arrangement is perfectly separate and distinct from the boring-machinery in its action, and neither over nor under feeding can possibly take place. The machine measures about 10 feet long, when shut up, by 1 foot wide, and 1 foot 2 inches deep. The stroke is 6½ inches long, and the travel of the propelling-piston is 24 feet; the weight of the machine without the carriage is about 2 tons. A much smaller and lighter machine is made for mines, quarries, and shaft-sinking, etc., where portable machines are requisite and space is contracted. The principle of this is the same as for the other machine, but the propelling cylinder is placed immediately beneath the borer; the total closed length of this machine is but 5 feet, and the weight 300 lbs., and Messrs. Roy are improving even on this machine. There is, in Mr. Pendred's opinion, no doubt whatever that this machine, or modifications of it, will exercise a great influence on coal-mining, and go far to supply the want of the age—a good efficient coal-cutting machine. The advance of the Goeschenen heading with Ferroux drills was 119.90 metres in August, and 135.90 metres in September. The advance with the McKean drills of the Airolo heading was in January 121.30 metres. The character of the rock is not stated in either case.

BISHOP'S PLAN FOR SUBMARINE TUNNELS.

By PERRY F. NURSEY.

(See next page.)

THE uncertainties and probable difficulties attendant upon the English Channel tunnel scheme, no less than those motives which have animated other earnest workers in the same direction—namely, a desire to afford a more easy, agreeable, and rapid system of communication between England and France than at present exists, led to Mr. Paul J. Bishop advancing a scheme for a railway carried through tubes laid on the bed of the Channel. In 1870, Mr. Bishop consulted the author upon the subject, and communicated to him the general features of his project. The author thereon worked out the engineering details of a tubular railway, which are shown in the drawings. Mr. Bishop's method of connecting the railway systems of England and France consists in having two distinct tubes of cast-iron which are to be laid in a parallel course on the bed of the Channel, each tube being laid with a single line of rails. The route selected is from Dover to Cape Griznez, between which points the deepest sounding is 30 fathoms, and the steepest gradient 1 in 100. The whole length of the line is 21½ miles, and the estimated cost is about one million sterling per mile for two distinct tubes. The tubes are shown in transverse section at Figs. 1 and 2. They will be elliptical in section, 4 in. in thickness, and cast in lengths of 5 ft., which will be bolted together internally through flanges 12 in. deep, cast on the end of each length. The tube will be lined with brickwork in cement, 12 in. thick, and over this will be laid a lining of ¼ in. boiler-plate iron: which will render the interior surface flush and even throughout, so that either the locomotive or pneumatic system can be employed. The outer dimensions of the tube will be 17 ft. 8 in. on the major and 14 ft. 8 in. on the minor axes of the ellipse, and the inner 15 ft. and 12 ft. respectively.

The weight of each section of the tube will be somewhat in excess of the weight of the water it will displace, so that it will remain quiescent upon the bed of the Channel. Before lowering, five sections of the tube will be bolted together into lengths of 25 ft. on board a pontoon or floating workshop, from which they will be lowered into position. Fig. 3 shows a section of the completed joint. Each end of the 25 ft. lengths will be fitted with a movable watertight wrought-iron bulkhead, part of which is shown in section at Fig. 4 and the whole at Fig. 5. Assuming a length to have been lowered and fixed in position in connection with the shore works, a 25 ft. length will be lowered directly in advance of

it by means of slings and chains, as seen at Figs. 1 and 6, the latter of which shows a length of tube being lowered, the general operation being seen from Figs. 7 and 8, which show respectively a side and end view of the pontoon. The slings will be bolted to the tube from the inside, and after the tube has been connected with the preceding length the bolts are partially withdrawn and the slings hauled up. The bolts are then screwed up again, the ends being left to project beyond the outside of the tube. The slings on the seaward end of the length of the tube assumed to have been laid, are provided with pulleys, under which are passed a set of hauling-chains, the ends of which are attached to the slings on the shoreward end of the tube being lowered. As soon as the latter reaches the level of the tube which has been laid, it is drawn towards it by the hauling-chains, which are operated from the pontoon.

Upon the bulkhead of the fixed length of tube is a cast-iron projection seen in Figs. 5 and 6. This is for the purpose of guiding the last lowered length of tube up to the face of the work, the guide fitting into a sheath or socket formed in the bulkhead of the unfixed tube. As soon as the tubes have been drawn close together, the screwing up is commenced from the interior of the laid tube, the screws having previously been placed in the flange of the forward end of the tube, and is continued until the flanges meet, a packing of india-rubber being interposed to make a temporary watertight joint. The joint is afterwards caulked from the inside with iron cement, and is thus made permanently water-tight. The flanges having been bolted together, the first bulkhead is removed, and the second bulkhead is then in view. The first bulkhead, owing to its elliptical form, can be placed on a special trolley and run back through the tube to shore for use for the next length. The guide of the second bulkhead is removed by unbolting from the outside, and thus a manhole is formed, by which the workmen can enter the length of tube just laid, and remove the body of the bulkhead by unbolting it from the interior. Fig. 9 shows a section of the tube with the wrought-iron bulkhead bolted to it by 4-in. bolts, the 3-in. bolts alternating with them, being those by which the lengths of tube are fastened together. The bulkhead is composed of four ¼-in. plates with three extra plates as a ring around the manhole where the guide is attached, as seen at Fig. 10, which shows the connection of the bulkheads to the flanges of the tubes. By the time that the bulkheads have been removed and the joint made good another 25 ft. length will have been lowered in front of the last laid length, and the process of connecting it with the seaward work is carried out as just described. As each length of tube is laid it will be secured in position by six screw piles screwed from the inside and passing through stuffing-boxes, three at each end of every 25 ft. length.

During the process of laying the tube, communication will be maintained with the shore and the advanced end of the tube by electricity, and the transport of men and materials will be effected by means of rails, which will be laid down as the work proceeds, and which may be the permanent rails of the system. The workmen will also be placed in electrical communication with those on the pontoon above, which will enable them to give directions respecting the lowering of the next section of the tube, the exact position of which they can ascertain by means of three glass sight-holes fixed in the bulkhead. The floating pontoon will be 400 ft. long, 100 ft. wide, and will have an opening in the centre 100 ft. long by 25 ft. wide, through which the lengths of the tube will be lowered. It will be attended by steam launches and tenders for conveying materials, etc., to and from the shore, and for shifting the anchors as the process of laying proceeds.

The ventilation of the tube when completed will be effected by means of engines of 1000-horse power, placed one at each end of the tubes. This power will be necessary for the proper ventilation of the tubes, but at the same time it may be used for the propulsion of the trains upon the pneumatic principle if desired. The work of laying the tubes may be expected to occupy five years, but if the seasons be moderate it might be done in three.

A favorite argument with some objectors to the iron tubular projects is that the sea water would have an injurious effect upon the metal. The author would meet this objection by the following extract from Maury's "Physical Geography of the Ocean": "Count Marsigli divides sea-water into surface and deep sea-water; because when he makes salt from surface water (not more than 6 in. below the upper strata) this salt will give a red color to blue paper; whereas the salt from deep sea-water will not alter the color at all. The blue paper can only change its color by the action of an acid. The reason why this acid is found in surface and not in deep sea-water is that it is derived from the air." Before the tubes are laid, however, all the ironwork will be well coated with Calley's Torbay oxide paint, of the protective qualities of which for ironwork the author has had favorable experience. But even assuming that there is a chance of the iron of the tube being attacked by oxidation, it would be some years before that could take place if properly protected in the first instance, and doubtless by that time the tube would be silted up into a solid mass, which would insure the permanency of the Channel railway.

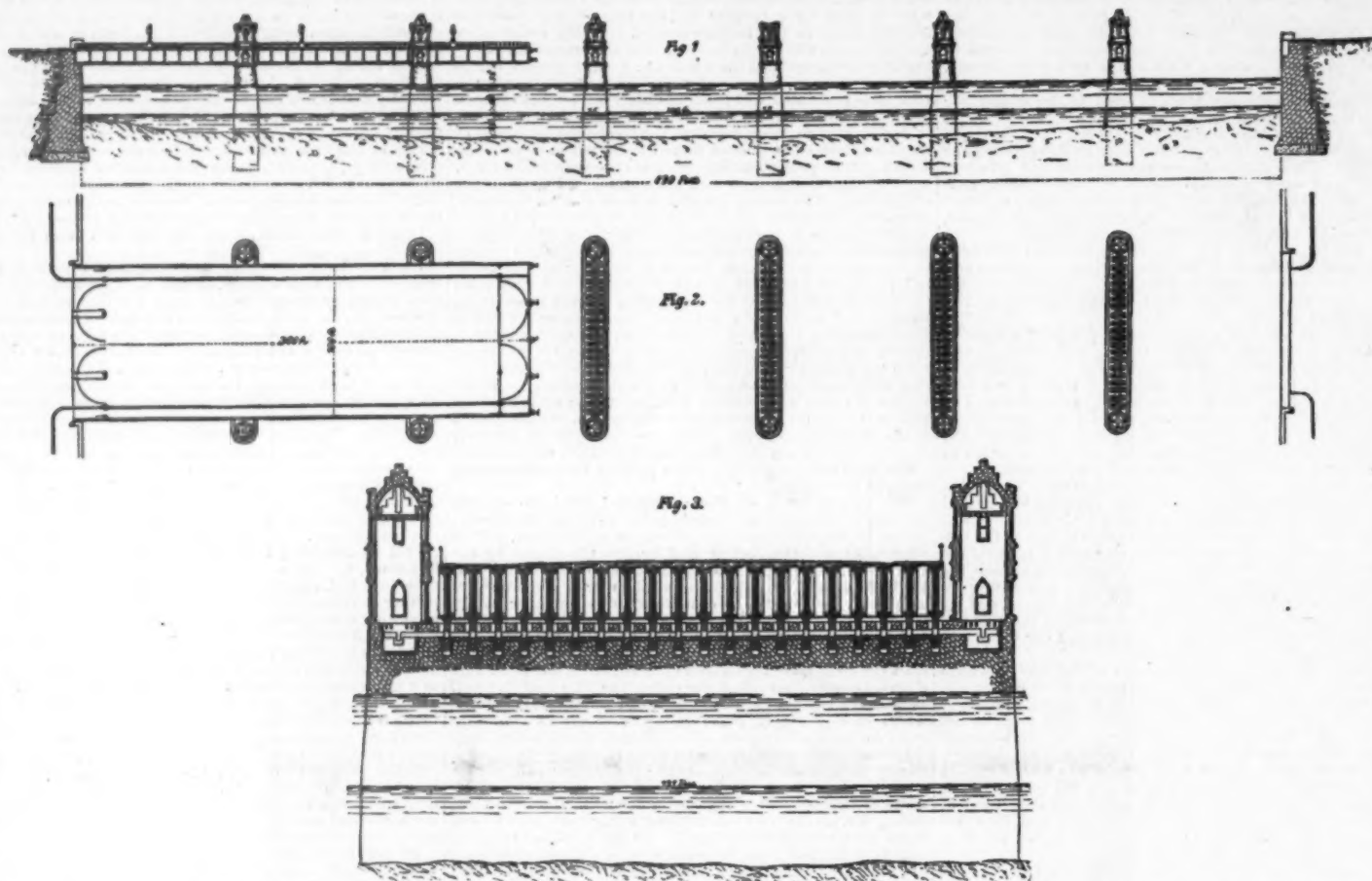
The following statement shows the weight of a 25-ft. length of the tube:

	Weight.	Tons.
Tube, 25 ft. length, cast iron.....	140	
Wrought iron plate lining.....	12	
Brick lining in cement.....	65	
Screw pile boxes.....	5	
Seaward bulkhead.....	16½	
Shoreward ".....	14½	
Slings (3 pairs).....	30	
	311	

Weight of each 25-ft. length of tube ready for lowering..... 311

The following is the author's approximate estimate for the double line of tubes:

Tons.		
1,503,600	Cast iron tubes, tapped and fitted ready for fixing in place, delivered f.o.b. in the Thames, at £7.....	£10,525,200
125,940	Wrought iron linings, bent, punched, and fitted ready for fixing, bolts and screws for fixing same, and screws for fixing together the lengths of tube, delivered f.o.b. in the Thames, at £15.....	1,878,600
1,628,540	Of iron work in the above items, including india-rubber and iron cement for joints, painting and all incidental items, including pontoons and tenders, and all machinery required, screw piles for anchoring tubes, bulkheads, slings, chains, permanent way, &c., at £5.....	8,144,200
	Brickwork lining.....	380,000
	Contingencies, 2 per cent.....	400,000
	Engineering, surveys, &c., &c., 2½ per cent on £20,000,000.....	500,000
		£21,748,000



PROPOSED ROLLING BRIDGE OVER THE THAMES, AT LONDON. DESIGNED BY MR G. BARCLAY BRUCE.

PROPOSED ROLLING BRIDGE OVER THE THAMES.

We illustrate one of the many schemes that have been from time to time proposed for conveying traffic across the Thames below London Bridge, without interfering with the navigation. The present plan has been prepared by Mr. G. Barclay Bruce, of Great George street, Westminster, and the general arrangement is clearly shown by the engravings, from which it will be seen to consist of a rolling bridge, the platform of which is 300 ft. long by 100 ft. wide. Six piers are erected across the river 100 ft. apart, and on each of these are placed a series of rollers and the necessary machinery for propelling the platform from shore to shore. By this arrangement a clear waterway of 700 ft. is secured, and the platform rests always at least upon two piers. When at either end of its travel, the platform will take a bearing on an abutment and two piers, and as soon as it is loaded with passengers and vehicles, the shafts on which the rollers are mounted are set in motion by the machinery in the piers, and the platform is moved forward until the end passes upon the rollers of the next pier, which are then set in motion, and so on until the opposite shore is reached, when the platform is again loaded, and the travelling action reversed.

The weight of the whole of the moving structure when fully loaded between the guard-gates at each end, with $1\frac{1}{2}$ cwt. per foot, is estimated at 5000 tons, and the total cost, including piers and all machinery, is 144,000*l*.

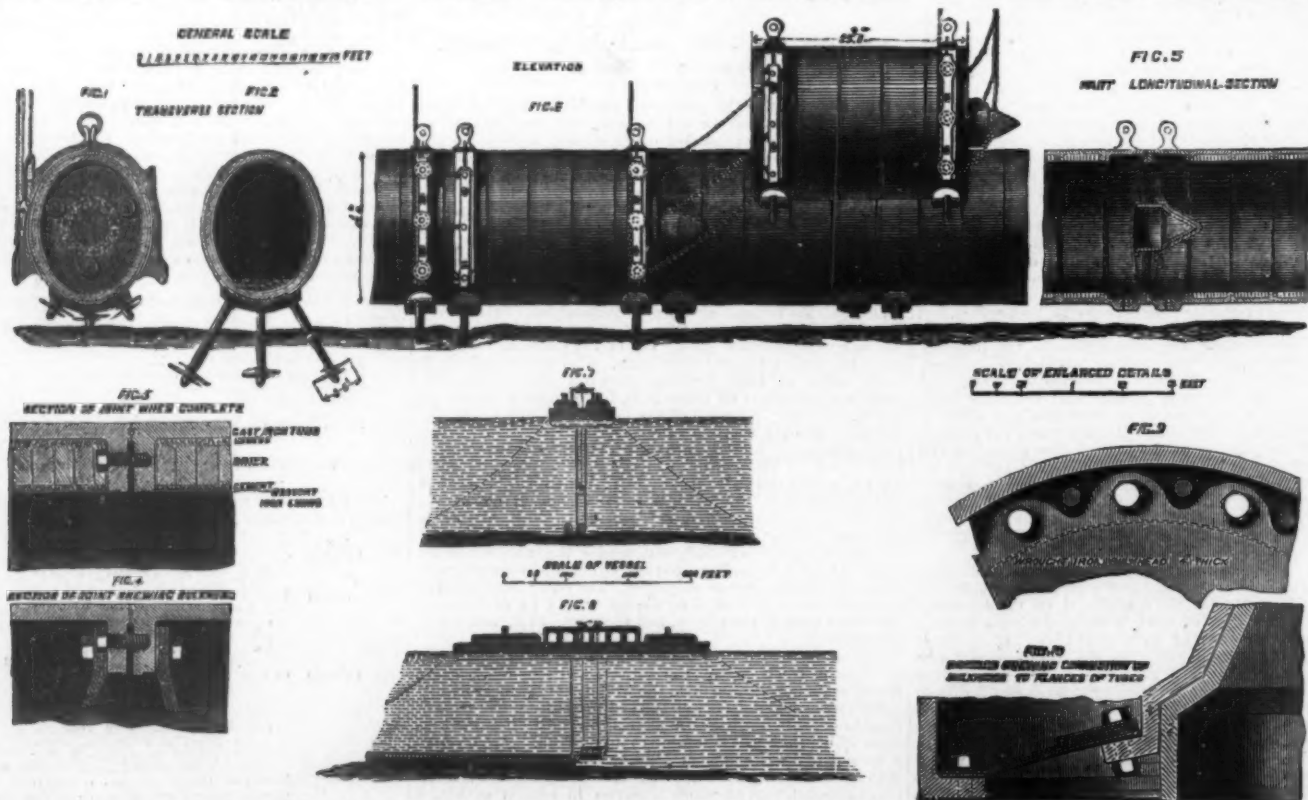
The advantages claimed for this peculiar and certainly original arrangement, as compared with the other proposed means of crossing the Thames below London Bridge, namely, ferries, high-level bridges, tunnels, and swing bridges, may be briefly summarized.

It is very justly urged that a ferry is at best a very imperfect means of conveying heavy traffic. With a range of tide of 18 ft., the approaches must be periodically inconvenient, or accompanied by delay and expense if hydraulic lifts are employed, as in the case of the new Thames ferry. Again, the difficulties of working a large ferry-boat broad side on to a swift-flowing tide in a crowded river, must be considerable, and inconvenient delays must be created from this cause.

The objection to a high-level bridge is very simple and very evident; its great height above the river, rendered necessary on account of the shipping, would involve enormous outlay, especially in the construction of approaches on both shores. Similar objections may be urged against tunnel

communication, unless the passengers and vehicles are lowered and raised at each end—a very serious undertaking if the traffic be heavy. A swinging-bridge is free from the objections urged above, but certain and frequent delays would be inevitable when the swing-span was opened for the passage of vessels, and these delays in a crowded river like the Thames would be a serious obstacle to the traffic.

Like the swinging-bridge, the rolling-bridge proposed by Mr. Bruce is free from the disadvantages of great height and long, costly approaches, and, moreover, the time lost in opening and closing the swing-span would be utilized in carrying the traffic forward upon the platform; but, on the other hand, the same delay must occur in each case to permit of passing vessels clearing the advancing platform. Indeed, this inconvenience may be greater than in the case of the swing-bridge, as there would be a larger number of openings for passing vessels, and thus there would be less control over the navigation. Mr. Bruce's estimate of the capacity of the bridge is 100 vehicles and 1400 passengers at each crossing, which would occupy only three minutes, but we should imagine that this estimate as to time is incorrect, on account of the inevitable stoppages for passing vessels.



BISHOP'S PLAN FOR CHANNEL RAILWAY TUNNEL.—(See preceding page.)

THE ANCIENT ROMAN AQUEDUCTS.

THE revival, in modern times, of efforts, guided by science, to supply cities and towns with abundance of pure water, renders the study of the works of the Romans, the apparent originators of this most beneficial branch of engineering, both interesting and useful. Especially is this the case to the citizens of New-York.

In the "Illustrations of the Croton Aqueduct," by F. B. Tower, published in 1843, the New-York aqueduct is succinctly described in a couple of sentences: "An artificial channel, built with square stones, supported on solid masonry, is carried over valleys, through rivers, under hills, on arches and banks, or through tunnels and bridges, over forty miles. Not a pipe, but a sort of condensed river, arched over to keep it pure and safe, is made to flow at the rate of a mile and a half an hour towards New-York." Dr. William Smith quotes this passage (Dictionary of Greek and Roman Antiquities), and adds: "A more exact description of a Roman aqueduct could not easily be given." The assumption that the Romans did not use pipes because they were ignorant of the laws of hydrostatics, is disproved by the fact that in certain portions of the works they did use pipes; and the aqueduct was preferred for the obvious reasons unnecessary to recapitulate, which guided the engineers of the Croton Aqueduct.

Pliny, Strabo, and other Roman writers have left notices more or less extended of the ancient aqueducts; but for the most detailed and perfect information, the world is indebted to Sextus Julius Frontinus, who was *Curator Aquarum* (Superintendent of the Aqueducts) under the Emperors Nerva and Trajan, A.D. 96-106. Frontinus was specially assiduous and thorough in his duties, and caused plans and models to be made of all the Roman aqueducts which existed in his time. These were nine in number, and he gives them as follows, in the order of the date of their construction: Appia, Anio (Vetus), Marcia, Tepula, Julia, Virgo, Alsietina, Claudia, Anio (Novus). Frontinus wrote a treatise *De Aqueductibus Urbis Romae*, which was unknown to the moderns except by citations in other authors, until the work was discovered by the Italian scholar Poggio, in the library of a convent in Italy, early in the fifteenth century. The aqueducts of Rome have been a favorite subject with modern antiquaries and scholars, and their picturesque ruins have been the subjects of paintings and engravings by many artists. The art of photography is multiplying the copies of the views of these interesting ruins. In the Roman Campagna, and especially in the vicinity of the city, these verdure-crowned remains look like the remains of cities; and in Rome itself, the ruins of the *castella* or distributing reservoirs are among the most interesting antiquities. The sources of the aqueducts were either in the Campagna or in the Apennines beyond. The former served for baths and for the supply of the lower portions of the city. The waters from the Apennines were carried to the highest parts of the seven hills on which Rome is built. The illustration which accompanies this article is after an engraving by Piranesi, a celebrated Venetian architect, engraver, and antiquary, who died in 1778. His voluminous works were republished by his sons in Paris.

Of the nine aqueducts described by Frontinus, three are still in use, and abundantly water the modern city. One of these is the *Virgo*, which still retains its ancient name. Tradition says that it was given to the aqueduct in honor of a maiden who discovered the source of its supply. It is not difficult to understand why its name is retained. This aqueduct was restored by Pope Pius IV. The *Felice*, another of the three, is said to be a part of the ancient Claudia, and was restored by Sixtus V. It is called after his conventual name, *Fra Felice*. The *Paola*, the third of the existing aqueducts, is the ancient Alsietina. By these three aqueducts the numerous fountains of Rome are abundantly supplied, throwing up their jets of water night and day, sometimes, as at St. Peter's, to a height of twenty to thirty feet. Fountains are met at every turn in the "Eternal City," even with the present supply. In the time of Procopius, the historian (the sixth century), there were fourteen aqueducts still preserved and in use, the work of successive praetors and emperors. But from the time of the division of the Roman Empire the aqueducts successively failed, until the care of the Popes arrested their complete extinction and preserved the three above mentioned. The daily supply of water by the nine aqueducts mentioned by Frontinus, was computed by him at 14,018 *quinaria*, or 27,743,100 cubic feet. Another calculation makes the supply equal to that carried by a river thirty feet broad, by six feet deep, flowing at the rate of thirty inches a second. When to the nine earliest some six or ten aqueducts less known are added; and when we consider that from three modern Rome gets so lavish a supply, the use of water in ancient Rome seems simply enormous. But the public and the imperial baths, the ever-flowing fountains, and the miniature seas provided for representation of sea-fights (*Naumachie*), created a demand for all that could be furnished.

History repeats itself. Those of our readers who can remember the expressions of public opinion, and the demonstra-

tions of public joy, with which the Croton water was welcomed in New-York about thirty-five years ago, can appreciate the terms in which Pliny speaks of the Claudian Aqueduct: "If any one will carefully calculate the quantity of the public supply of water, and, along the distance which it traverses, the arches built, the mountains perforated, the valleys levelled, he will confess that there never was any thing more wonderful in the whole world." As has been well said, the aqueducts of Rome are her true monuments, testifying to the enlightenment and enterprise of the conquerors of the world. And these monuments are not confined to the Imperial City itself; but their remains in the provinces of the empire testify how science and beneficent rule supplemented the work of military conquest.

Of the oldest of the aqueducts, the *Aqua Appia*, no undisputed traces remain. It was commenced in the year B.C. 313,

of the Claudia and the Anio Novus entered Rome by separate conduits, but on the same arches, as shown in the engraving.

Such is a brief notice of the nine most conspicuous aqueducts of ancient Rome. The sum of the length of all the ancient aqueducts is computed at something like three hundred miles. It remains now only to notice the methods by which the waters were purified. This was done by a reservoir, in which, as the water passed through, it deposited its sediment. The reservoir (*peccina*) had two tiers of chambers, into which the stream entered by the upper chamber on one side, passed thence into the lower, and rising flowed out of the upper chamber on the other side; the passage being through apertures in the bottom of the upper chambers and dividing wall of the lower. The principle was something like that of the "trap" under a modern sink. The ancient Romans do not appear to have had any process of analysis, but distinguished

the quality of waters by their use. They avoided as far as possible river currents or turbid waters for the supply of their aqueducts; and they found by experience that the waters from the calcareous soil of the Apennines was vastly superior to that of springs in the volcanic soil of the Campagna. Hence the care taken to conduct by different conduits, though on the same arches, the waters from different sources.

The suggestion of this article is drawn from *La Nature*, though its statements are largely supplemented from other sources. That periodical observes that the source of the waters which once supplied the now broken aqueducts near Rome may be surmised with reasonable probability from the incrustations deposited on their sides. A black and spongy deposit is the trace of the ancient Appia, while the waters of the Marcia and the Claudia have left their sign in beautiful alabaster. At the best the waters of Rome are more highly charged with salts, rendering them "hard," than would serve the purpose of modern art. But, as our French contemporary remarks, the Roman water supply was not used in steam-boilers.

[Condensed from *La Nature*.]

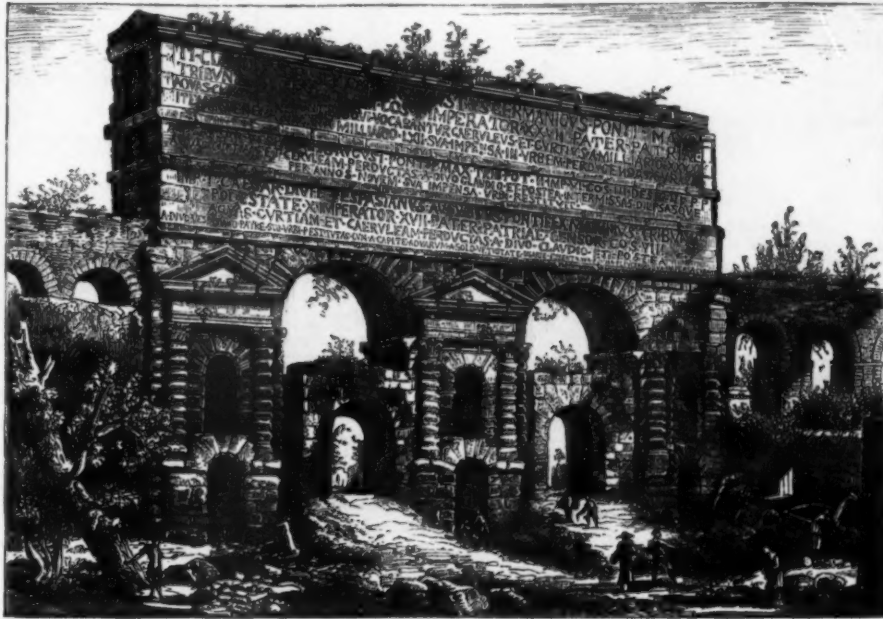
STRAIGHTENING THE COURSE OF THE DANUBE RIVER.

THE Danube River, through its subdivision into a large number of small branches, formerly produced, at the north-eastern limit of the Austrian capital, an archipelago of islands. These were covered with beautiful groves, and to the people of Vienna, for over two centuries, the locality was a favored pleasure-ground. Of late years, and especially since the woods have been cut down, the separate streams have dried or become marshes, and, in consequence, the salubrity of a portion of the city has been seriously impaired. Navigation also, always active on the river, has been, through the same cause, impeded, and despite the facilities offered to vessels by the canal which traverses the city, the necessity of engineering operations to improve and deepen the river has long been evident. The rapid extension of the northern faubourgs of the city has resulted in showing the need to be urgent, since severe and almost periodical inundations have caused large damage in the built-up portions.

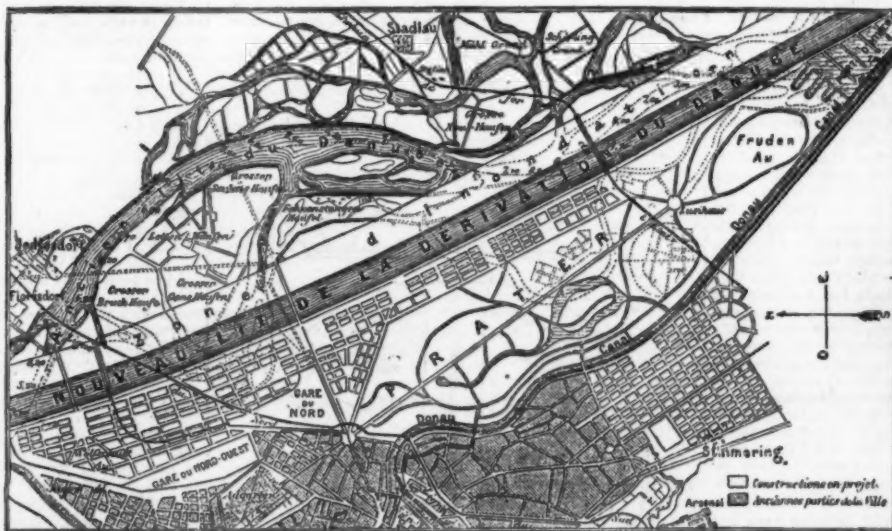
As early as 1810, the subject of the required improvements was agitated, but it was not until 1850 that any definite steps were taken toward beginning the enterprise. These, however, took the form of suggestions and projects, but led to no practical results, and thus the matter lay in abeyance until, in 1862, a flood occurred, which submerged all the northern faubourgs, and carried great suffering into a population of over 100,000 souls. A new commission was then appointed to take prompt measures, and two years later this body seriously set to work to consider the large number of plans submitted to them. The following programme was finally decided upon:

1. To regulate the course of the Danube from the fields of Kuchelau, at the mouth of the canal, to Fischamend.
2. Extension of the project of straightening and improving above and below these limits.
3. Improvement of the section of the river, and of its accessory streams.
4. Defence of Vienna, by improved construction of new banks.
5. Deepening of the river-bed and feeding of the canal, so as to allow constant navigation.
6. Establishment of large landing-quays and a winter harbor.
7. Construction of suitable accommodations for the reception of travellers, troops, and their munitions of war.
8. Construction of docks, store-houses, and basins, destined to transform Vienna into a great centre of navigation, and to facilitate the transshipment of merchandise.
9. Establishment of quays over a distance of 4700 metres, thus bringing the same and also the new river-bed nearer to the city.
10. Suitable arrangements for the construction of a central station for the railroads terminating at Vienna.
11. Construction of bridges and roads and of railroads on the Danube, with regard to the needs of navigation.

This vast programme was in principle accepted, but the mode of execution gave rise to long and vexed discussions, in which many engineers, Austrian and foreign, took part. Some advocated simply the improvement of the natural river-bed, while others maintained that an entirely new bed was



ANCIENT ROMAN AQUEDUCT.



THE NEW BED OF THE DANUBE RIVER AT VIENNA.

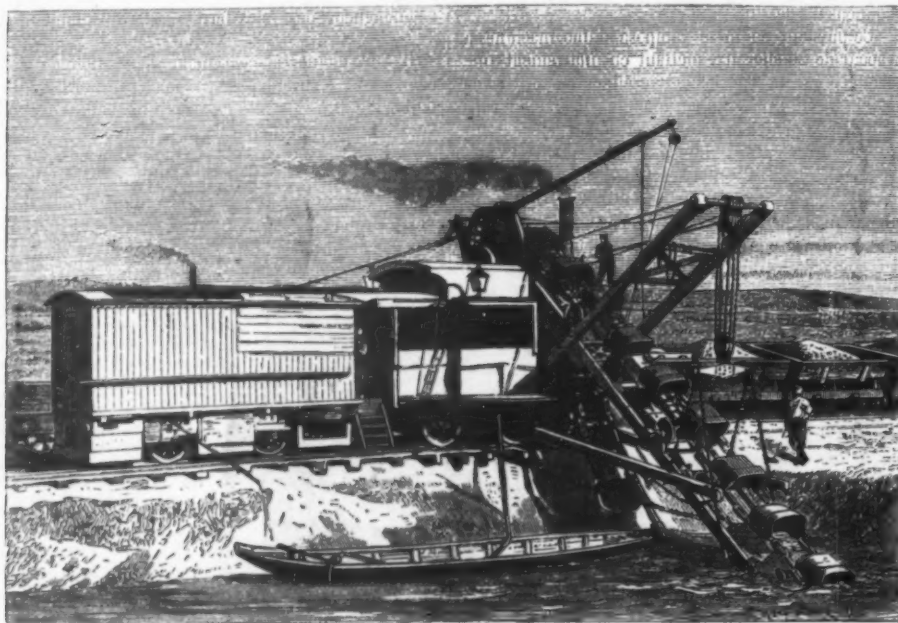
mile on solid substructions, and the rest on arches. The *Aqua Tepula*, built B.C. 127, was afterward, B.C. 33, connected with the *Aqua Julia*, constructed in that year. The two, in separate conduits, were carried above the conduit of the *Aqua Marcia*. On the same arches the three aqueducts entered Rome, one above the other, the upper being the *Julia*, the next the *Tepula*, and the lower the *Marcia*.

The *Virgo* and the *Alsietina*, which both date, like the *Julia*, from the time of Augustus, have been noted as two of the three aqueducts which supply the present city. The *Aqua Claudia* and the *Anio Novus* were both commenced by Caligula, and finished by Claudius, between the years A.D. 36-50. The *Claudia* was nearly 47 miles in length, and for about ten miles was conducted on arches. Its waters were, next those of the *Marcia*, the best which came to Rome; and, as mentioned above, from the remains of the *Claudia* the present *Felice* was constructed. The *Anio Novus* had a length of nearly 50 miles, and was in some of the valleys which it traversed supported on arches over a hundred feet high. The waters

necessary. The last-named project was finally adopted, and the State, the province, and the city, the three parties interested in the rapid prosecution of the work, made arrangements to meet the estimated expense of 24,000,000 florins (about \$9,600,000).

A new commission was formed in March, 1860, charged with carrying out the details of the operation, and labor was at once begun, under the auspices of the French contractors, MM. Castor, Courreux, and Hersent.

The new bed, 15 kilometres in length, commences at Nussdorf, above Vienna, and terminates below, at the village of Kaiser Eberdorf. As is shown in the map given on the preceding page, it follows a slightly curved course, the convexity being turned toward the city, to which it is much nearer than was



THE COURREUX EXCAVATING APPARATUS.

the natural bed. The entrance of the canal has been greatly improved, and provided with a lock which allows of its being closed during winter, and protects the city against the invasion of ice, at the period of the breaking up of the same. The section of the new bed is divided into two parts: the minor bed, which ordinarily receives the greater portion of the water, is 285 metres long, and is from 3 to 3.5 metres in depth below mean level, or zero of the scale. The major bed, intended as a channel for surplus water, adds to the first a breadth of 515 metres, and its depth is 2 metres only below the mean level.

On the left bank, there is an insubmersible dike elevated 6.3 metres above the mean level. On the right bank, a vast platform is made by the material dredged from the bed. This platform, completely sheltered from inundations, is designed to receive the important constructions indicated on our map by small non-shaded rectangles. The works to be executed, were divided into the following:

	Cubic metres.
Earth excavations.....	6,557,000
Dredging.....	7,524,000
Masonry.....	207,000
Paving of slopes and foundations.....	446,800
Old foundations and piling removed.....	285,800
Fascine work.....	27,000

It was, besides, necessary to construct the lock at the head of the canal. A portion of the excavation, about half, was executed by the shovelling into carts and barrows, but the balance was done by the excavator represented in our second engraving. This powerful machine was composed of a 20-horse steam-engine, which actuated a chain of buckets carried on a frame, as shown. The movement of the chain was such, that the empty buckets descended from above the frame, while the full ones arose below. On reaching the emptying-point, the vessels were discharged by automatic mechanism. The whole apparatus was mounted on a carriage which ran upon three rails; and a second steam-engine, of 4-horse-power, served to move it from place to place. The excavated material, on leaving the buckets, fell into a conduit which led it to transport wagons running on a second and parallel railroad. The entire machinery, which had already been employed at the Suez Canal excavation by the inventor, M. Courreux, gave at Vienna excellent results, both in point of economy and rapidity of work. The machinery employed during the entire operations included an immense amount of material. There were 4 excavators, 9 dredgers, 18 locomotives, 397 wagons, 160 transport-boats, besides steam-cranes, stone-breakers, towing-vessels, etc., the mere care of which necessitated the construction of five huge workshops, besides extended barracks and hospitals for the large force of workmen.

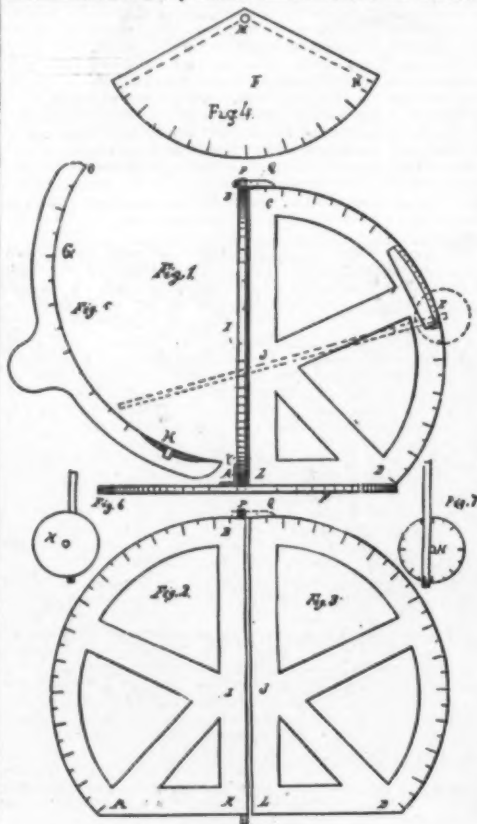
NEW INSTRUMENT FOR SOLVING PROBLEMS OF NAVIGATION.

By T. HILL, Portland, Me.

A B and C D are two meridians—the one marked latitude, the other marked declination—which are placed together in such a manner that the edges B K and C L are in contact for their whole length; and the two meridians may open and shut upon these edges as a hinge. F is a plate in the form of a sector of a circle, marked hour-angle. To this plate the meridian C D is fastened at right angles, while the latitude-meridian is set at any required angle with C D by the graduated edge of F. On the latitude-meridian are two hinge-thumbs, P P', the lower one of which plays in a hole, M, in the plate F. The upper one plays in a hole in the ear Q, at the top of the declination-meridian C D. The declination-meridian bears a vernier, E, carrying a steel pin at its vernier-point. This vernier is movable upon the arc of C D. Both meridians are of the same radius, and are graduated from the pole Q down to thirty degrees below the equator at A and D. G is an arc of altitude, graduated from two degrees below the horizon at O to the zenith H. It is of precisely the same radius as the meridians, and bears at its zenith-point a compass-card, pierced at the centre with a hole to fit the vernier-pin.

The use of the instrument is to solve the spherical triangle, which is formed when the zenith-point H is placed upon the pin of the vernier E, and the altitude-arc laid across the latitude-meridian. The sides of the triangle are known by inspection, because they are graduated arcs. The angle at the pole Q is measured upon the graduated hour-angle arc of F. The angle at E is measured by the compass-card attached to the zenith of the altitude-arc. The third angle, at the intersection of the altitude-arc with the latitude-meridian, remains to be measured, which is done not in the triangle itself, but in a symmetrical triangle formed by moving the vernier-pin to the latitude on the declination-circle, and the altitude-arc to the declination on the latitude-circle. The new triangle thus formed being symmetrical with the old triangle, the compass-

card now measures what was the third or unmeasured angle, and thus the triangle is completely solved. In this manner the instrument finds the time from an altitude taken by the sextant. The vernier E is placed at the declination of the heavenly body observed, the zenith-point is put upon the pin, and the hour-angle is altered until the observed altitude on the altitude-arc exactly reaches the latitude of the observer.



NEW NAUTICAL INSTRUMENT.

By making the altitude equal to zero, this method gives at once the time of sunrise and sunset.

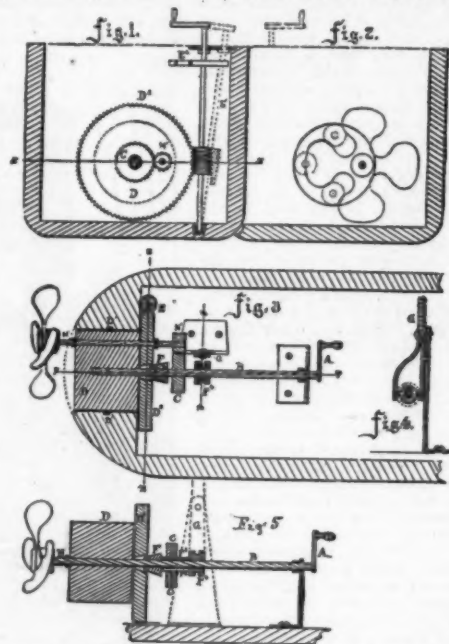
If, in the same problems, the symmetrical triangle is formed as above described, the compass-card gives the azimuth of the heavenly bodies observed. The instrument also solves the problems of great-circle sailing.

The meridians being clamped at an angle equal to the difference between the longitude of the ship and of the desired port, the vernier E is placed on the declination-meridian at the ship's latitude, the zenith of altitude is put upon it, and the altitude-arc laid over the latitude of the desired port. The compass-card now indicates the course, while the co-altitude is the great-circle distance. Thus the navigator, by this machine, can solve all the principal problems of navigation relating to time, latitude, longitude, azimuth, and great-circle sailing without the labor and the liability to error of numerical or logarithmic computations.

CHANGING POSITION OF PROPELLERS.

By G. H. BROOKS, Hancock, Md.

This invention relates to mechanism for raising and lowering the propellers of vessels and boats propelled by steam or other similar power, and also for changing their position horizontally with reference to a line drawn vertically through the centre of the vessel or boat; and it consists of a revolving cylinder or drum D, placed in the shell or frame-work thereof, and so constructed and arranged that the shaft H to which the propeller is attached may have its bearings formed in or upon the same, and so that by a full or partial rotation of said cylinder the position of the propeller may be changed, for the



purpose of adapting it to the propulsion of an empty or loaded, or partially loaded vessel or boat, and so that when the same is used in canals or narrow streams of water, and when coming alongside of docks or wharves, it may be shifted from the side of the centre line of the vessel or boat, on which it would be most exposed to injury, to the opposite side, where it would be the least exposed; and it further consists in the construction, combination, and arrangement of some of the parts, as will be more fully explained hereinafter.

In order that propellers for boats which run upon narrow streams may be thoroughly effective in their work, they should be so arranged that when the boats are empty, the same may be lowered, so as to have the proper proportion of their blades below the surface of the water; and it is of still more importance that they should be capable of such an adjustment as will bring them into such a position when partially or fully loaded. It is also important that their propellers should be capable of such an adjustment as will enable their operators to change them from the side of the centre of the boat which is nearest to the bank of the canal or river to that side thereof which is farthest therefrom, where the water is of greater depth, and where the blades are less liable to come in contact with the banks or other solid substances which would be likely to damage them.

Upon the shaft B there is secured a gear-wheel, C, which is to be of such a diameter as to cause it to give to the propeller the required number of revolutions to every revolution of the engine-shaft.

Directly in rear of the shaft B there is a cylinder or drum, D, which is fitted into an aperture in the stern of the boat, it having upon its periphery an annular projection, D', or other suitable device for preventing the endwise movement of the same, and for preventing the water from passing it; or a stuffing-box may be placed at its outer end, and so arranged that by screwing up its gland the leakage will be prevented.

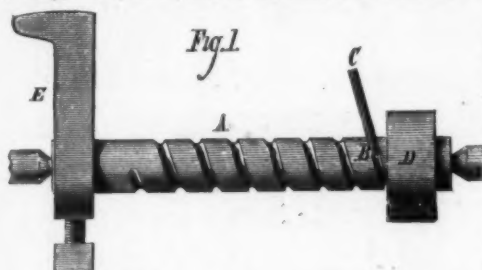
Upon the inner portion of the cylinder D there is a projecting flange, D', the periphery of which is formed into cogs or teeth for the reception of the threads of a worm, E, as shown in Figs. 1 and 3, said worm being mounted upon a shaft E', the lower end of which rests in a step, while its upper end is held in position by a bracket, E'', in which it is made adjustable, as shown in Fig. 1, so that the worm may be made to mesh with the toothed periphery of the cylinder D, and thus by being rotated by the crank upon its upper end, be made to rotate the cylinder and change the position of the propeller either vertically or horizontally. I have shown another method of changing the position of the propeller, which is the one I prefer to use, and which consists in forming in the inner head or end of the cylinder a tapering aperture for the reception of a conical clutch, F, which is made to slide freely upon the shaft B, with which it rotates, it being operated by means of two rods or levers, F' F'', which pass through grooves formed in the wheel C, and are connected to an annularly-grooved ring, G, which is moved horizontally by means of a forked lever, H, the construction of which is shown in Fig. 4. When it becomes desirable to change the position of the propeller by means of this mechanism—as it generally will when the engine is in motion—the worm E is placed in the position shown in dotted lines in Fig. 1, and the lever G is placed in such a position as to cause the conical clutch to enter the cavity formed in the head of the cylinder, which will cause the same to be quickly rotated, and this movement will place the propeller in any of the four positions shown in Fig. 2, or at any point between either of them, its position being determined by observing the position of the pinion on the end of its shaft with reference to the wheel which drives it; or it may be by an indicator arranged for that purpose.

When the propeller has been properly adjusted, the worm may be placed in the position indicated by full lines in Fig. 1, and the cylinder will thus be held in its desired position; or the same result may be accomplished by causing the surfaces that come in contact with the cylinder to hold the same by their friction, in which case the worm may be dispensed with. The shaft H, which carries upon its outer end the propeller, has its bearings in the cylinder D, it being arranged eccentric to the centre thereof, and at such a distance therefrom as to cause the pinion H' upon its inner portion to mesh into and be driven by the gear-wheel C upon the engine-shaft.

HOW TO MAKE SPIRAL SPRINGS.

By JOSHUA ROSE.

WITH spiral springs made in quantities and with special tools, machines, and appliances, it is not our present intention to deal, but rather to give instructions as to the best method of making spiral springs in an ordinary machine-shop. First, then, in selecting the material of which the spring is to be made, we must bear in mind that unless the circumstances of the case necessitate that the spring be put to its utmost tension, brass will do as well as steel, and in fact better, providing the strain or the spring is well within its capacity. Suppose, for instance, that the length or diameter of the spring is of no immediate consequence, then a brass-spring will serve equally as well as a steel one, especially if the situation in which the spring is to be used renders a steel one liable to corrosion, not only because of the rusting through of the metal, but also for the reason that the corrosion of a steel-spring destroys both the equality and degree of its temper. If the space in which the spring is to operate is confined so that the spring is made as small as possible, in proportion to its duty, and is, hence, used to the limit of its tension, it is



imperative that it be made of either spring or double-shear steel. For electrical purposes, brass-springs may be used, excepting in cases where from any derangement of the insulation, the spring may be liable to become heated, for brass softens very easily, and a brass-spring that has lost any of its temper by becoming heated is, as a spring, utterly worthless.

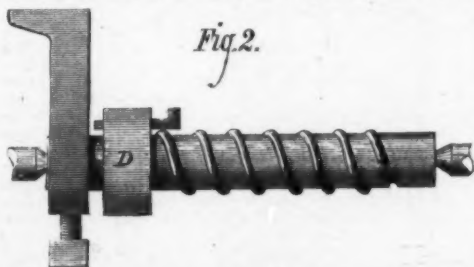
The wire used for making brass-springs is specially prepared for the purpose of being sufficiently drawn, without being annealed, to harden it by closing the pores of the metal in the same principle that copper is hammer-hardened, that is to say hardened by lightly hammering its surface. For flat-springs there is also manufactured a special rolled sheet-brass. Both the wire and the sheet metal may be easily distinguished by the close and polished appearance of the surface of the metal.

In using steel for springs, we have the following considerations. If the springs when finished require to be polished, the polishing should be the first operation performed, for the following reasons: the surface of all hammered, rolled, or drawn metals is closer grained at and toward the outer surface of the metal, and in the case of wrought-iron and steel the outer metal is of better quality, and it is found in practice that springs made of steel retaining its forged, rolled, or drawn surface, are stronger in proportion to their thickness and length, than those having a polished surface. It is also found in practice that the hardness of springs lies mainly at and near the outer or skin surface, so that if we make a spring of the unpolished metal, and polish it after it has been formed and tempered, we shall find that it has lost in the polishing process a great deal of its elasticity. It is furthermore much more difficult and expensive, as a general rule, to operate upon the skin of the metal when it is formed into springs, and after it is tempered, than it is upon the metal in the strip or as wire. It is true that the plan of operation recommended involves the necessity of polishing after the hardening and tempering takes place, but it is impracticable to produce a good spring if its surface is ground away to an appreciable extent after the hardening process has been performed. As a rule, then, unpolished and unground springs are better than others, and should always be employed when the assigned duty is proportionately great.

Cold rolled or drawn iron wire may be used to make springs in which their sizes are large in proportion to the duty required. The iron wire must, however, have been sufficiently cold rolled or drawn without being annealed to produce upon it a close-grained and clean surface, having, at least, a dull polish.

Cast steel may be used for springs, but it is very apt to break, especially in very cold weather.

Having selected our material we proceed as follows:—If the spring is to be of brass we select a mandril to run between the lathe centers and having upon it a spiral groove or thread



of the requisite pitch, but a little smaller than the diameter of the required finished spring, because the spring unwinds a little as soon as it is released from tension around the mandril. The mandril must be sufficiently longer than the required length of spring to admit of the application of a lathe dog to drive it, allowing sufficient clearance between the end of the spiral groove and the dog. Near one end of the mandril a small hole is drilled through, there being sufficient space between the hole and the end of the mandril to admit of a loose washer being placed thereon; the bore of this washer requires to be rather larger in diameter than the outside diameter of the spring, when wound upon the mandril, and also requires to be provided with a keyway and key. We may now proceed to wind our spring (supposing it to be made of wire sufficiently light to admit of its being held in the hand during the winding process). Slipping the washer over the mandril we place the latter in the lathe between the centers, and then slide the loose washer back against the dead center of the lathe; we then pass the end of our spring wire through the hole in the mandril and pull it tightly against the mandril, bend it over the corner of the hole by tapping it lightly with a small hammer. We are now ready to wind the spring as shown in Fig. 1, in

which A represents the mandril, B the small hole with the wire inserted, C the wire, D the loose washer and E the driver. While keeping a stiff tension on the wire by pulling it against the mandril, we start the lathe and wind the spring, closing it around the mandril, if it does not wind closely, by tapping it with a hammer. When the spring is wound to the requisite distance we slip the washer up and drive the key home, as shown in Fig. 2, and then cut off the wire. Our next operation is to take the mandril from the lathe and holding it level on an anvil or iron block, lightly hammer the spring all around the mandril, which will set the wire to the mandril and tend also to increase the hardness of the brass. Were we to omit this hammering the spring would, as soon as released from the mandril, spring into coils of a larger diameter and become shorter in length, whereas the hammering sets the wire to its newly acquired form. It is not well to hammer the wire around the mandril while the latter is between the lathe centres, which would damage the centres and bend the mandril.

If the wire is too stiff to be held by the hand against the mandril with sufficient force to cause it to bend closely round the mandril, while the lathe is slowly revolving, we must, if the lathe is a self acting one, put on the gearing, necessary to cut a thread of the same pitch as the spring requires to be, and then fasten in the tool-post of the lathe, a grooved piece of metal as shown in Fig. 3, A representing the mandril shown in section, B the spring wire, C the piece of metal acting as a guide and also to bend the wire close to the tool-post of the lathe in which C is fastened. If the lathe is not a self-acting one and has a hand-slide rest, we may take the screw out from the straight feed of the rest and use the metal guide, thus allowing the groove to carry the wire along, the groove being in this case at least as deep as $\frac{1}{8}$ of the diameter of the wire. Having wound our spring, we must place the washer in position, as shown in Fig. 2, and cut off the wire. Then if the wire is of iron or brass we must take it to an anvil or iron block and well hammer it all over its circumference, not promiscuously, but beginning at one end and following along the wire with the blows delivered not more than $\frac{1}{4}$ of an inch apart; for unless we do this we can not maintain any definite relation between the size of the mandril and the size of the spring. If, however, the wire is of steel we must take the mandril with the spring wound on it and fastened by the washer as shown in figure 2, and heat them to a very low red heat so as to set the spring to the mandril, because the hammering process would only tend to close the grain of the metal and thus add to its elasticity without having much effect towards closing the spring around the mandril except the spring be made of very small wire.

HARDENING.

Spiral springs made of light wire, or those long in proportion to their diameter, should be placed on a mandril fitting easily to their bore, and should be heated while on the mandril, otherwise they are apt to become bent and the coils disarranged during the heating process. The fire should be clear, of green coal. It is a good plan to make a good clear fire around a piece of gas-pipe, and to insert the spring in the gas-pipe, which will facilitate getting the spring to an even heat all over. In many shops there are small open furnaces



used to case-harden small work by the prussiate of potash process, and such furnaces serve excellently well to heat the springs in.

The springs being heated to a cherry-red must be plunged perpendicularly endways into clear water having the chill taken off, and held in the water until quite cold. If on taking the spring from the water its surface is found to be black and not well mottled with white spots, it is in all probability not sufficiently hardened, which may arise from inferiority in the quality of the steel, or because it was not sufficiently heated. Steel of good quality is sufficiently heated when hot enough to just form scales when taken from the fire. If it is found difficult to properly harden the steel (which may be known from the fact that well-hardened steel is white all over when taken from the water), the water should have sufficient salt dissolved in it to make it a strong brine, and the hardening process repeated. Here it may be noted that the whiteness of the surface is a better test of the degree of hardness of the metal than testing the metal with a file would be, because steel of a straw-color will not file, and therefore any degree of hardness between a straw-color and a white hardness can not be distinguished by a file.

Furthermore, the temper of a spring lowered from white hardness to a blue is not the same as that lowered from a black or even mottled hardness to a blue; and hence to attain the nearest possible equality in the temper of springs all those having a mottled appearance or dark on the surface should be re-hardened. The appearance of dark colors on either hardened steel or case-hardened iron is evidence that the hardness is not that of the highest attainable degree; the deeper and more fanciful the colors the less the degree of hardness. To really test the hardness of the surface of metal, we must take a new, or at least a good, dead smooth file and apply one corner of it to a corner and on a flat or circular surface of the metal to be tested, pressing the file very firmly against the work. A coarse file, even if a new one, is useless to test with.

TEMPERING.

The most reliable method of tempering an ordinary spring is to blaze it off—that is, to try or boil it in the oil, the latter being sufficiently heated to cause it to take fire and blaze. The spring should be occasionally (before being finally removed from the oil) taken from and re-dipped in the blazing oil two or three times; and after the blazing takes place freely all over the spring, and has on the last removal from the tank burned out at any one part of the spring, the latter should be dipped in luke-warm water and left then to cool off. The advantage of this plan is that it diminishes the danger of any one part of the spring being lowered more than another, while at the same time the heating takes place sufficiently slowly that the metal gets equally heated all through. The thicker the spring the longer it should be allowed to blaze, it being dipped frequently into the blazing oil and removed, then re-dipped and removed, which is done to insure that every part of the spring shall be equally heated, and to give

the steel time to get heated equally inside and out. It is well in blazing a spring to reverse it in the pan, to turn it end for end, and to revolve it so that the blazing oil shall not run down along one side of the spring, in which case the oil would be blazing on the bottom side of the spring, and the flames passing through the coils of the top side (on which the oil will have run and burned off) will make the latter the softest.

If care is taken that the spring is blazed off equally all over, that is to say, that it is kept so that the oil is never burned off the spring at any one part, which may be insured by frequently dipping the spring and turning it about well while holding and blazing it out of the pan or tank; and if the blazing process is continued sufficiently to insure that the spring has had time to be equally heated all through, the blazing process is absolute and certain to produce good work, providing the hardening was properly performed.

A good oil composition for blazing is made in the following proportions: One gallon of spermace oil, one pound of rendered beef-suet, one gill of neatfoot oil, and about one quarter pound of resin. The pan or tank in which this composition is used should have a closely-fitting cover, so that the blaze may be put out, when the tempering is finished, by putting the cover on.

SELF-STOPPING PULLEY-BLOCK.

AN adaptation of the ordinary pulley, so that the weight may remain suspended in any position without the pulley-rope being held or fastened, is shown in the accompanying pulley known as "Wilke and Lappe's pulley-block." The simplicity of the apparatus explains itself from our engraving, which likewise shows that the ordinary pulley-block might (by a very simple modification) be made to possess the fore-mentioned property, at present only found generally in those pulleys in which more than half the force applied is lost by friction. To attain this object, according to the system before us, it would become merely necessary to replace the

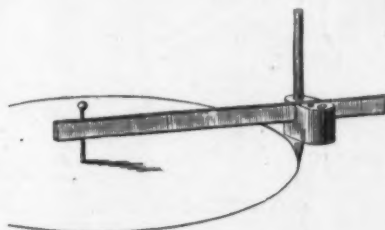


SELF-STOPPING PULLEY.

centre-pin of the ordinary block by a longer pin, so as to admit the latter to carry a strong brake-bracket (similar in form as shown in our wood-cut) outside the sheaves with the brake-piece, playing on the end-rope. In Wilke and Lappe's pulley-block, this characteristic feature consists merely in the addition of a brake arrangement, which renders them somewhat similar to the differential or epicycloidal blocks. Although their velocity-ratio is the same as with the ordinary corresponding pulley-system, yet it possesses a considerable working advantage over the latter, inasmuch as the load need not be constantly held suspended by the user. These blocks appear to recommend themselves specially for use in the construction of high buildings, garrets, ships, mills, breweries, and wells, etc., on account of their being worked by rope and not by chain, and they are consequently cheaper and more manageable in long haulages than chain pulleys would be. The rope after being fastened to the bottom of the top pulley must be so passed round the pulley that the end to which the power is applied passes immediately under the brake-piece. To allow of the load being lowered, a cord is fastened to the brake, the load is slightly lifted, the cord is pulled, thus relieving the pulley-rope from the brake, when the load will then descend of its own weight, care being taken not to let go the pulley-rope.

BEAM COMPASS.

THE ordinary beam compass, with its sliding sleeves, fitted with adjusting screw, springs, and pen and pencil adjustment, at best forms a somewhat complicated instrument, and one liable to derangement. We illustrate, says *Engineering*, a modification of the ordinary form, which ought to find favor with every draughtsman, whilst its extreme cheapness, which follows as a matter of course upon its simple construction, is an additional advantage. It consists simply of a radius bar of mahogany, through one end of which a pin is placed, which serves as the centre round which circles may be struck. Sliding on the bar is a block of cork with rounded



BEAM COMPASS.

ends, and having pierced through it four holes of varying sizes, through either of which an ordinary drawing pen or pencil may be placed, the elasticity of the cork holding them tightly in place. A penknife may also be placed in one of the holes, and the instrument used for cutting out circles on paper or cardboard. The piece of cork retains a firm and steady hold upon the mahogany bar, along which it may be made to slide, the bar passing through a slot cut in the cork as shown. Messrs. Charles Johnson & Co., of 2 Howard street, Edinburgh, Scotland, are the makers of this little instrument.

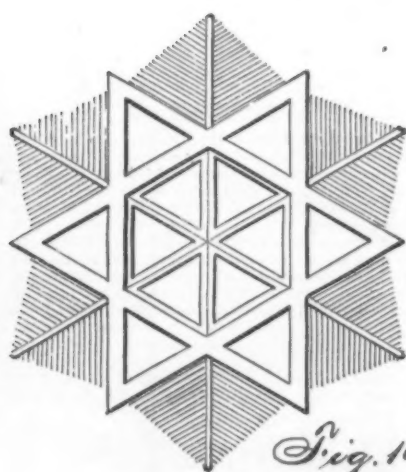
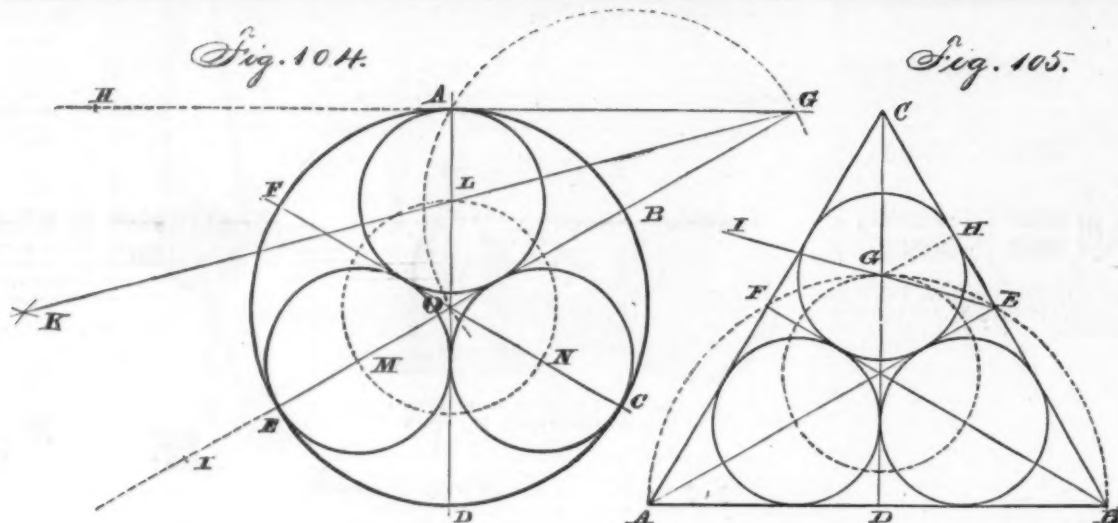
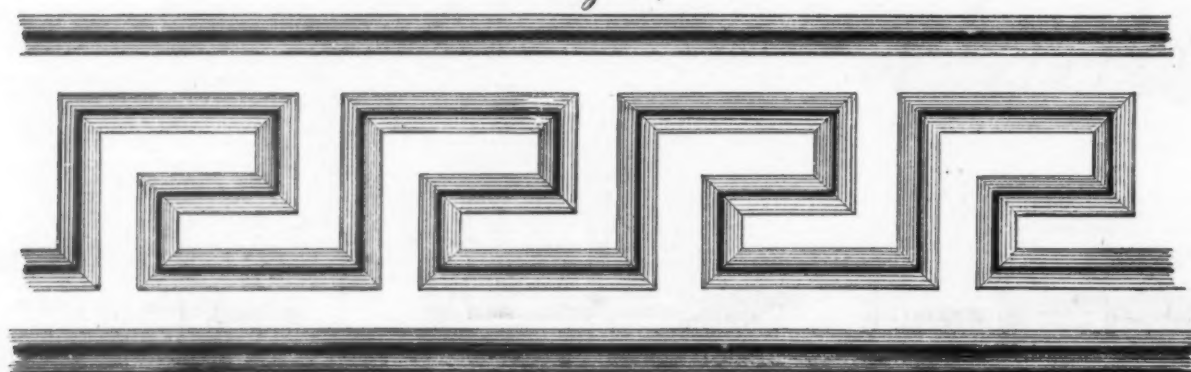
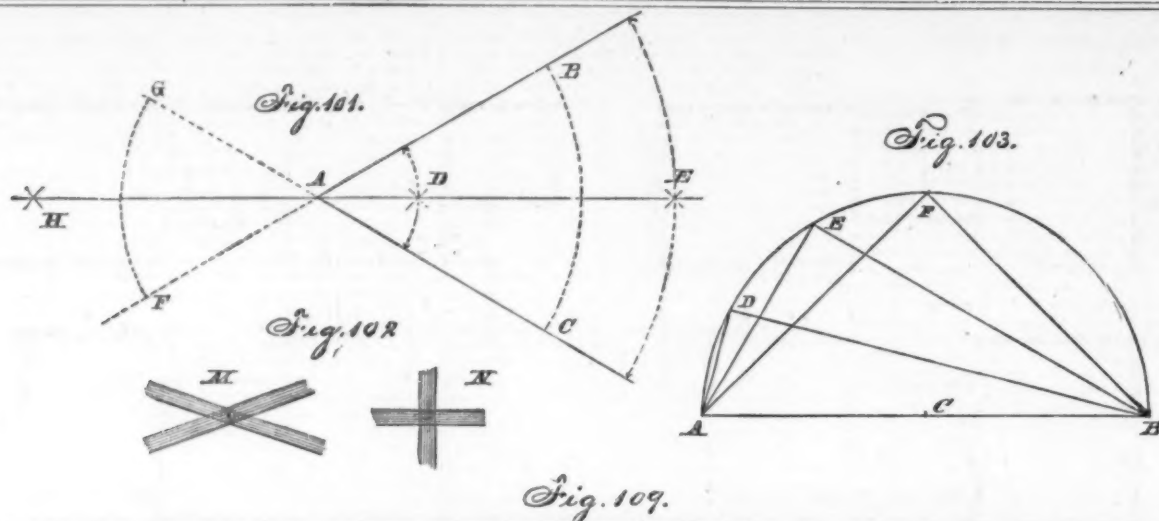


Fig. 106.

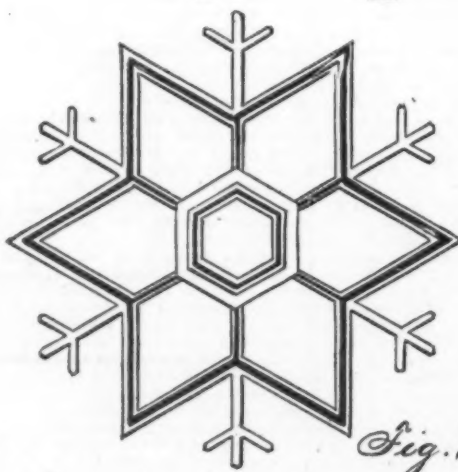


Fig. 107.

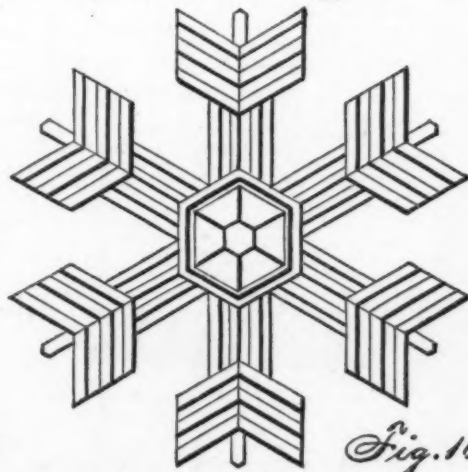


Fig. 108.

LESSONS IN MECHANICAL DRAWING.—(See page 310.)

CONCRETE BUILDING.

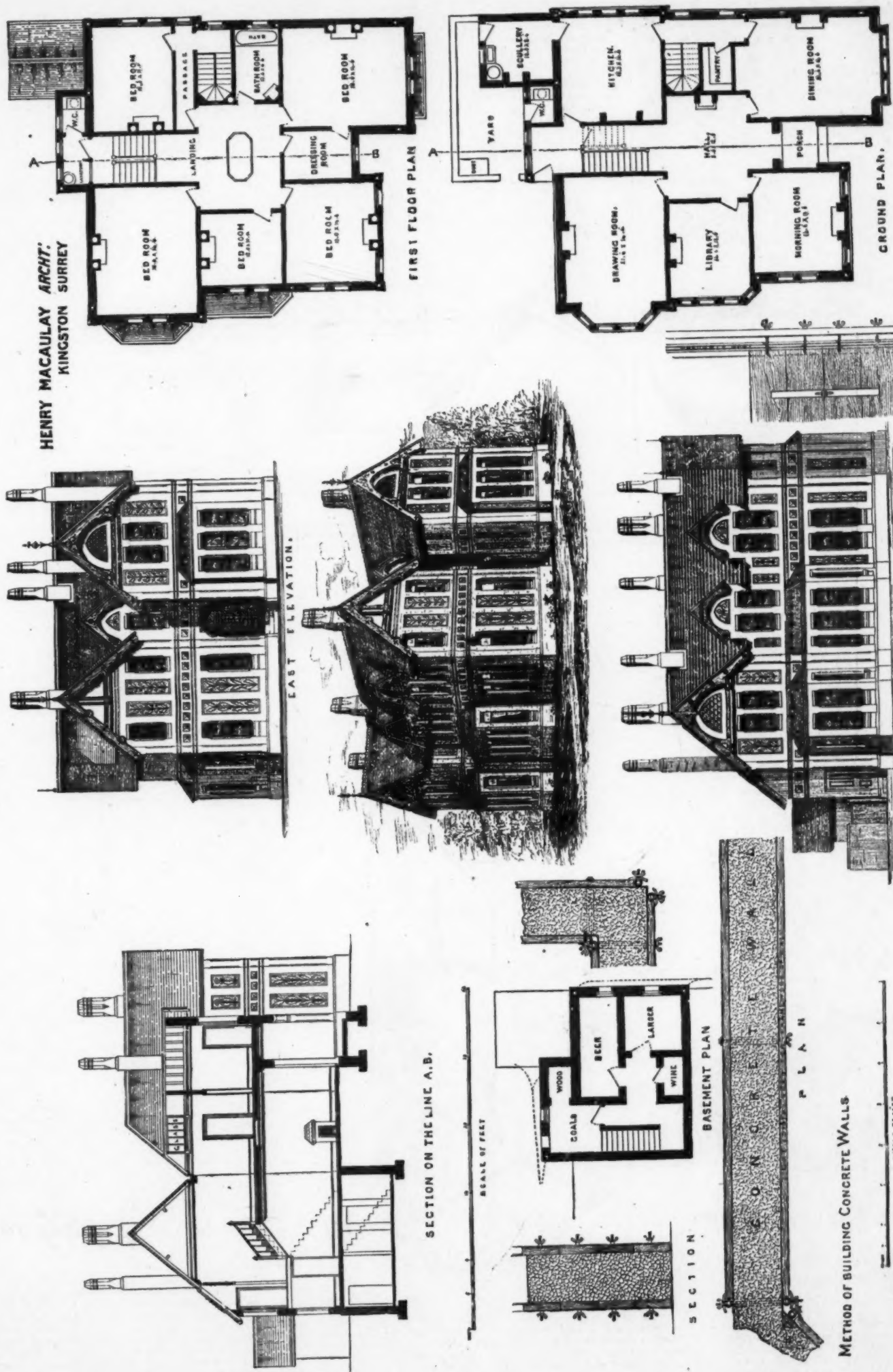
(See Illustration on following page.)

IN OUR SUPPLEMENT No. 13, March 25th, 1876, we gave a drawing and various particulars for the practical construction of farm buildings, halls, etc., of concrete. In many localities, the procurement of brick and stone is a matter of difficulty or of great expense. But sand, water, and gravel are more or less abundant everywhere, and if to these is added a small proportion of cement, we have a most enduring, reliable, and economical material for building, with which structures of every size and variety may be expeditiously constructed.

Our valued cotemporary, the *London Building News*, recently offered a series of prizes for designs for cottages of concrete, and we give herewith the illustrations of the third of these prize designs, which is by Mr. Henry Macaulay, ar-

chitect, and is intended to be erected by means of the concrete box apparatus of Mr. Thomas Broughton, the essential parts of which are illustrated on our page of drawings. By means of these simple devices, any building—plant, scaffolds, boards, joists, etc., can be utilized for the purpose of construction by the use of certain appliances in the shape of "slotted tubular standards of iron," and a combined "wall brace and gauge," which can be set in any position. By using boards, deals, planks of any length, depth, or thickness, and which may be again brought into requisition, expedition in building is insured; these boards or joists may be removed quickly; walls and projections of any thickness and depth may be formed as the work goes on, and the boards can be secured and set in any position by one man. If old building materials are not accessible, builders may obtain boards of the nearest timber-merchant. It is stated that, with a duplicate set of standards, the walls of buildings may progress

without intermission, each set of standards being fitted with a kind of fishing-rod joint, which enables them to be worked one over the other. We understand some large buildings have been erected by these appliances in Great Guilford street, London, and elsewhere. As executed on the Eastleigh estate for Sir John D. Astley, Bart, M.P., near Warminster, it is stated that stone-work, with box-ground quoins and hammer-dressing walls, cost £12 17s. 8d. per rod; brick-work of kiln bricks, £13 16s. 3d.; while the concrete work executed with Broughton's concrete building appliances cost only £7 10s. 3d. per rod. In the latter there were 8 yards of gravel, digging, screening, etc.; 4 yards of stone-packing (washed); 31½ bushels of Portland cement; 5½ of ditto, in stucco; 15 bushels of washed river grit, and 1000 gallons of water. The weight was only 15 tons and 16 cwt., compared with 22 tons 8 cwt. for brick-work, and 10 tons for the stone-work.



HENRY MACAULAY ARCHT.
KINGSTON SURREY

CONCRETE BUILDING.—DESIGN FOR COTTAGE, BY HENRY MACAULAY.—(See preceding page.)

SOLDERING.

By GEORGE M. HOPKINS.

SOLDERING, or uniting the surfaces of metals by means of a more fusible metal or alloy, is one of the indispensable arts, and one which once thoroughly understood is invaluable to every mechanic, whatever his branch of mechanics may be.

It is the purpose of this article to describe such of the processes for soldering as may be of the most general application.

A few solders, the metal to which they are applied, and their appropriate fluxes are tabulated below.

NAME.	COMPOSITION.
Soft, coarse.....	Tin, 1; Lead, 2.
" fine.....	" 2 " 1.
" fusible.....	" 2 " 1; Bis, 1
Pewterer's.....	" 3 " 4 " 2
Spelter, soft.....	Copper, 1; Zinc, 1
" hard.....	" 2 " 1
Silver, fine.....	Silver, 66.6; Copper, 23.4; Zinc, 10
" common.....	" 66.6 " 31 " 3.4
" for Brass and Iron.....	" 1. Brass, 1.
" more fusible.....	" 1. Zinc, 1
Gold, for 18 Carat Gold.....	Gold, 18 Carats fine, 66.6
" more fusible.....	Silver, 16.7; Copper, 16.7
Platinum.....	Some as above with a trace of Zinc. Fine Gold.

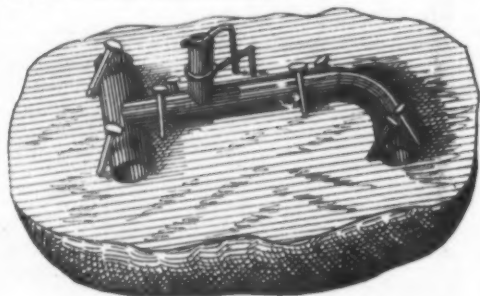


Fig. 1.

MATERIAL TO BE SOLDERED.	SOLDER.	FLUX.
Tin.....	Soft, coarse or fine.	Rosin or Zinc, Chl.
Lead.....	"	"
Brass, Copper, Iron and Zinc.....	"	Zinc, Chl.
Pewter.....	Pewterer's or fusible.	Rosin or Zinc, Chl.
Brass.....	Spelter, soft.	Borax.
Copper and Iron.....	" or hard.	"
Brass, Copper, Iron, Steel.....	Any Silver, S.	"
Gold.....	Gold, S.	"
Platinum.....	Fine Gold.	"

The chloride of zinc solution is prepared by cutting zinc in muriatic acid to repletion, and diluting it with an equal quantity of water. For iron, a small quantity of sal-ammoniac may be added. For large work, where spelter is used, it is powdered and mixed with pulverized borax—the mixture made into a thick paste with water and applied with a brush.

Soft solders are fused with a copper, or blow-pipe after the application of the appropriate flux.

While the work is still hot and the solder fluid, any surplus may be nicely removed with a moist brush. A mat-joint may be made between closely-fitting surfaces by placing a piece of tin-foil between the parts, and fusing in a plain, or blow-pipe flame.

For small work spelter and silver solders are fused by means of the blow-pipe; the work being laid upon a charcoal or piece of pumice-stone. It is often desirable to flank the work with an additional piece of charcoal, to economize all the heat of the flame, as well as that resulting from the combustion of the coal. If the work is of such a character that it is inconvenient to clamp or rivet it together, or even to wire it, it may be kept in place upon the coal or pumice-stone by means of tacks forced in at points, where they will be effectual in holding the work. When tacks are unavailable, parts may be held by wire loops and stays. (See Fig. 1.)

If part of the work has been already done, and it is desired to unite several pieces, having parts which have been previously soldered, in close proximity, these parts may be held in any position, and at the same time the joints already soldered may be prevented from melting by encasing the work in the following manner. (See Fig. 2.)

Take equal parts of plaster-of-Paris, and fine, sharp sand; add a sufficient quantity of water to make a thick batter, and

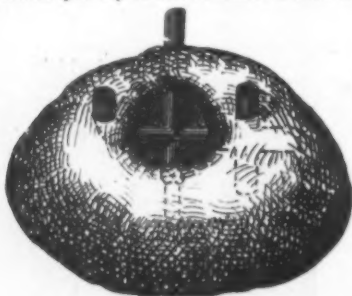


Fig. 2.

Imbed the work in it, leaving the entire joint to be soldered, and the adjacent parts exposed. Care must be taken to not get the plaster into the joint, as that would prevent the solder flowing.

It is difficult to hold all the various parts which are to be united so as to apply the plaster; the parts may be put into position one by one, and fastened temporarily by means of a drop of wax, which, when the work is encased and the plaster sets, may be readily melted out and the flux and solder applied. In every case where it is possible, the flux should be well brushed into the joints before placing the work on its support. A convenient way of preparing flux for small work is to rub a piece of borax about, with a few drops of water, on a porcelain slab or common slate until it appears like paste; this should be applied to the work with a camel's hair pencil. Small pieces of solder are dipped into the borax paste and put on the joints of the work. A pair of tweezers will be found convenient for this.

When the job is encased as in Fig. 2, it may be placed in a common fire until it has nearly attained a red heat, when it will be found that, on applying the blow-pipe the solder will readily flow with little expenditure of time and breath.

Just here, perhaps, it is well to notice the action and use of the blow-pipe and the structure of the blow-pipe flame.

When a jet of air from a blow-pipe is directed into a gas or alcohol flame the form of the flame is changed to a slender cone, having at two points characteristics which differ widely. There is a slender internal pencil, having a fine blue color, which is known as the reducing flame, shown at *a* in Fig. 3, and an external flame *b* enveloping the blue pencil, having a more indefinite form and a brownish color. This is the oxidizing flame. A piece of metal—tin, for example, placed at the apex of the outer or oxidizing flame is rapidly oxidized, while the same piece placed at the point of the internal or reducing flame immediately assumes a globular form and has the brilliant surface of clean melted metal.

The rationale of this is that at the extremity of the oxidizing flame there is intensely heated oxygen in condition to unite with anything oxidizable; while at or just beyond the inner or reducing cone are unburnt gases having a high temperature and a strong affinity for oxygen, and consequently any oxyd placed at this point will be deprived of its oxygen and reduced to a metallic state.

From this the conclusion will be readily arrived at that the proper point in the blow-pipe flame to effect the fusion of solder is just beyond the apex of the reducing flame.

To produce a uniform continuous jet with the ordinary blow-

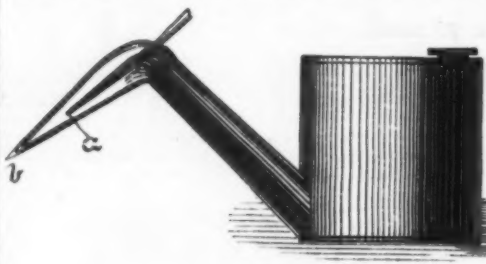


Fig. 3.

pipe is an attainment which, to some, is most difficult. It is very easy to state that it is only necessary to cause the mouth to maintain the jet at the instant of inspiration, but it is quite another thing to do it. The blowing, in light work, should, for the most part, be done with the mouth alone. It must be made to act the part of a pump or bellows, receiving its air supply from the lungs, but forcing its contents through the blow-pipe, principally by the action of the tongue. Let the tyro close his lips tightly, and with his tongue alone, independently of his lungs, force air into his mouth until his cheeks are distended to their fullest extent.

This done, and all is learned; for it is now only necessary to place the blow-pipe in the mouth and continue the action of the tongue, when it will be found that a continuous blast may be maintained without difficulty, and the lungs may be used or not at pleasure. Let it not be understood from the foregoing that the cheeks are to be puffed out while blowing. This is not advisable.

Often, even to those who are accustomed to the use of the blow-pipe, protracted operations are tiresome. In view of this, although a number of devices have been brought out for producing a continuous blast, the one shown in Fig. 4 is suggested. It consists essentially in a gasometer of small dimensions, having a small pipe which reaches above the water inside and terminates in a nipple at *a*. There is a valve in the top, shown in Fig. 5, which consists in a flap *b* of leather, very thin rubber, or oiled silk, placed under holes in the top and retained by springs *c c*. A weight *d* is placed upon the top to give the requisite pressure. A rope attached to an eye in the top passes over a pulley in the ceiling—or, if the apparatus is put in the cellar, simply passes up through the floor. The operation is obvious. The upper portion of the gasometer is raised by means of the rope; air passes into the valve in the

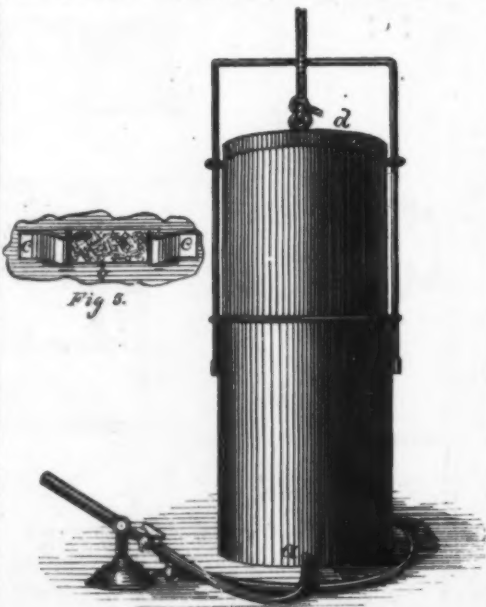


Fig. 4.

top and is retained; it passes out through the nipple *a* and thence through the rubber tube attached to a blow-pipe of any construction.

A gasometer of this sort, the upper portion of which is 12½ inches in diameter and 18 inches high—fitting into a lower vessel having a diameter ½-inch greater, and the same height—with a valve in the top covering thirty or forty ½-inch holes, and weighted with 25 or 30 lbs., will give a strong blast for twenty to thirty minutes. It is readily recharged with air. The supply to the blow-pipe is regulated by means of a cock.

A blow-pipe of peculiar construction—designed by the writer—shown in Fig. 6, has some qualities which recommend it for soldering, and also for other blow-pipe operations. Fig.

7 is a sectional view of the ball *D*. Fig. 8 is a longitudinal section of the nozzle.

This blow-pipe is in fact a modification of the annular compound blow-pipe. A pipe *A* which is attached by means of a pivoted connection to a standard, is turned in a right-angled elbow at its outer extremity, and is fixed to a short sleeve *a*, which is somewhat contracted at its outer end. *B* is a slide, provided with a spring-gib, to ensure a certain amount of friction on the pipe *A*, and a set-screw *b* to fix it at any point. This slide supports the air-tube *C*, and the ball *D*. The sleeve *a*, and air-pipe *C* are axially in line, so that when the nozzle is moved into the sleeve their apertures are truly concentric, and when in the position shown in Fig. 8, the larger part of the nozzle should fit the sleeve tightly.

The ball *D* collects the moisture, the air passing down the tube *d* and upward through the passage *e*. The sectional views are full-size; the elevation one-half size.

The best size for the air-pit, for all purposes is ¾ inch. The annular space for the exit of gas around the air-nozzle should not be more than ⅛ inch in breadth. Gas is supplied through the tube *e*, and air through the tube *f*.

When the parts are in the position shown in Fig. 8, with the air and gas supply in proper proportion, a fine blue pencil from ¼ to 3 inches or more in length is produced. By sliding the air-nozzle back as in Fig. 6, and using a strong blast, an intense solid flame is produced, capable of doing all that can be reasonably required.

This blow-pipe when connected with the apparatus shown in Fig. 4, seems to answer all the requirements for any purpose whatever. The weight on the gasometer may be reduced, when the gasometer may be filled with oxygen, and the operator will enjoy all the benefits of an oxyhydrogen jet, producing the lime-light, fusing refractory substances, and performing any of the brilliant experiments consequent to the use of a compound blow-pipe.

An instrument of this kind, when used for soldering, permits the use of both hands, which is a matter of no small moment.

Work that is too large to be readily soldered by the means already noticed, may be done in a charcoal or coke fire with a blast. Even a common fire of coal or wood may often be made to answer the purpose.

Brazing or hard-soldering of any kind must not be tried in a fire, or with coals, or tools which have the least trace of soft solder or lead about them. Neither must the brazing of work which has been previously soft-soldered be attempted. A neglect of these cautions insures failure.

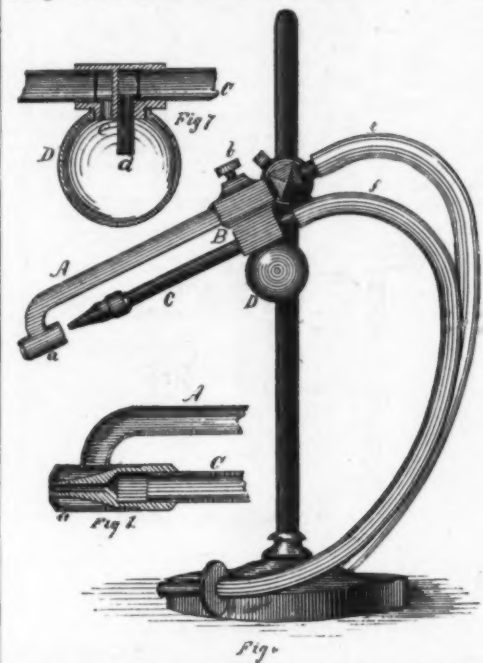


Fig. 5.

A wash of clay applied to surfaces which are not to be joined, prevents the flow of solder.

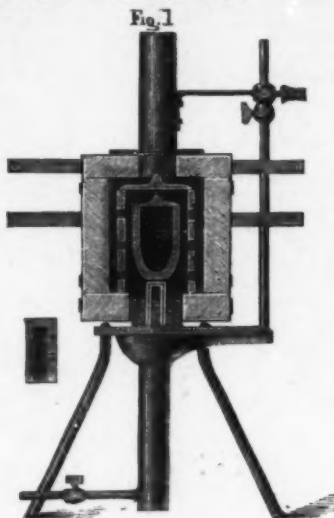
The vitrified flux may be readily removed by boiling the articles for a few moments in dilute sulphuric acid. This is best done in a copper vessel.

IMPROVED LABORATORY FURNACE.

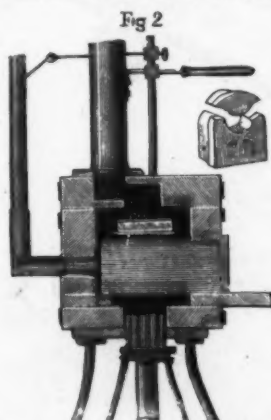
INGENIOUS arrangements for the convenient and economic production of a high temperature in the laboratory have from time to time been referred to in the *Mining Journal*, and the gas-furnace designed by Mr. Charles Griffin (Messrs. J. J. Griffin & Sons), of Garrick street, London, and represented in the accompanying diagrams, is certainly one of the best yet introduced. It is designed for chemical operations at a white-heat without the aid of a blowing machine, and in use has been found to work efficiently, whilst the new method of supporting crucibles in gas-furnaces which has been at the same time introduced has given general satisfaction. The crucibles are usually either suspended in a pierced plumbago-cylinder, or supported on a trivet-grate, both of which are liable to break when white-hot, and, therefore, a cause of trouble and expense. Crucibles, moreover, vary so much in form and size that they are often not suspended from these cylinders exactly in the focus of a heating power. Trivet-grates have this advantage that they interfere with the direct action of the flame upon the crucible, and, if made slightly, they break when heated to whiteness.

By the new form of burner used in Mr. Griffin's gas-furnace, these defects are remedied. In the new burner the circle of gas jets are enlarged so as to leave a space round the central jet. An atmosphere similar to those used in Hoffmann's combustion furnace, but of greater bulk and strength, is dropped over this central jet, and forms a solid support for the crucible; this support does not readily break, but should an accident happen it can be replaced at the cost of a few pence. It brings the bottom of the crucible exactly into the focus of heat, and itself supplies a portion of the heating power of the burner. It also enables one to use any crucible at hand, independent of its form or size. A strong lateral arm, cast on the body of the burner, supports an upright iron rod which carries the chimney of the furnace. By prolonging the legs of the burner upwards they are made to

carry the clay furnace, and thus by doing away with a stool or other support the construction is simplified and the cost lessened. A plumbago-cylinder, to deflect the flame and entrap the heat, is placed round the crucible, and is covered with an ordinary crucible-cover, by removing which the crucible can be inspected. These fittings, however, present nothing new, being adapted from Griffin's blast gas-furnace, which was introduced sixteen years ago.



Access to the crucible in the furnace is gained by turning aside the chimney, and lifting the top-plate of the furnace, which is provided with handles for this purpose; these handles do not become very hot even when the furnace is at a white-heat. The power of these new burners is very remarkable, one of small size, consuming only 20 feet of gas per hour, and having a chimney 4 feet high, being capable of fusing $\frac{1}{2}$ lb. of cast-iron in 35 minutes from the time of lighting the gas, or of melting gold, silver, or copper in crucibles placed within a muffle measuring 5 inches long by 3 inches wide. If a chimney 6 feet high be employed, cast-iron can be melted in crucibles placed within the muffle. A burner of larger size, consuming 40 feet of gas per hour, will melt cast-iron in crucibles placed within a large muffle measuring 8 inches long by 4 inches wide. In the crucible-furnace it will melt 1 lb. of cast-iron in 35 minutes, 2 lbs. in 45 minutes, 3 lbs. in 55 minutes, and 4 lbs. in 65 minutes, from the time of lighting the gas. It is thus seen that when a white heat has been once obtained 10 minutes' time is required for the fusion of every additional pound of iron.



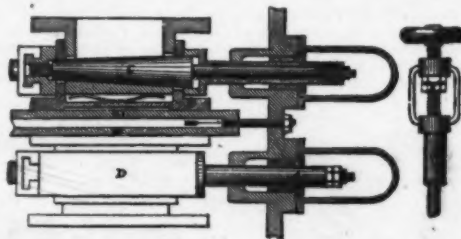
These results, attainable with certainty and rapidity, are believed to be the highest that have hitherto been placed at the command of the chemist. The proper admixture of gas and air is judged of from the color and quantity of flame which passes up the chimney. To enable the operator to see this flame three small holes are bored in the chimney. The flame is not seen at the upper hole unless the supply of gas is too large, but it is always visible at both the lower holes. In the diagram, Fig. 2, the muffle is provided with a small draught-flue, having a regulating cap on its upper end. In the small furnaces this is omitted, and the muffle is slotted in the usual manner. The cover of the furnace is now made without the zigzag-opening in the roof. The burner of the muffle-furnace is the same as (Fig. 1) that used in the crucible-furnace.

THE TAYLOR-WEATHERHOGG BALANCED SLIDE-VALVES.

THE engraving represents the valves of a double-cylinder engine, showing one valve in plan and the other in section. The principle consists in the balancing of the ordinary slide-valve by means of a balancing-plate adjusted by a wedge or cone C, which forms a part of the valve spindle. The slides shown have circular flanges or lugs cast on them, which interlock into corresponding flanges or lugs cast on the inner sides of the balancing plates B. In each of the flanges are cut suitable openings, through which is passed the cone or wedge part of the spindle C, until the latter comes in contact with the flanges. The driving spindle is secured to a strap D, which also surrounds and carries the valve and balancing-plate. The openings cut through the circular flanges are slightly elongated, which permits the valves to relieve the cylinders of any back pressure occasioned by priming. We are informed that with this system of relief to the cylinders no water taps are required to be fixed to the cylinders.

One important feature in this arrangement is that the valves may be adjusted without removing the steam-chest covers, the cone parts of the spindles C pass through one end of the steam-chest cover, and have sleeves A secured to the straps D, which works in suitable stuffing-boxes; the adjustment is effected by the lock-nuts E, as shown. By this arrangement, when the cones C are screwed down into the straps the

action draws the valves and balancing-plate from their seating, against the counter action of the steam, whilst by unscrewing the cones in the contrary direction the valves work with full pressure of steam on, thus showing that no possible damage could arise from carelessness, or otherwise, by the adjustment. This system is equally applicable to single or compound engines, and for marine engines by the application of the wedges or cones the usual blow-through pipes and cocks may be dispensed with, by allowing the wedge spindles to be made of sufficient length and keying a strap on to the sleeve A (as shown in the broken part) and having a hand-wheel for regulating the balancing in place of the lock-nuts as previously described. When the valves are properly balanced the adjustment is secured by the lock-nuts E upon the cone the spindle E, as shown, and when it is desired to blow through



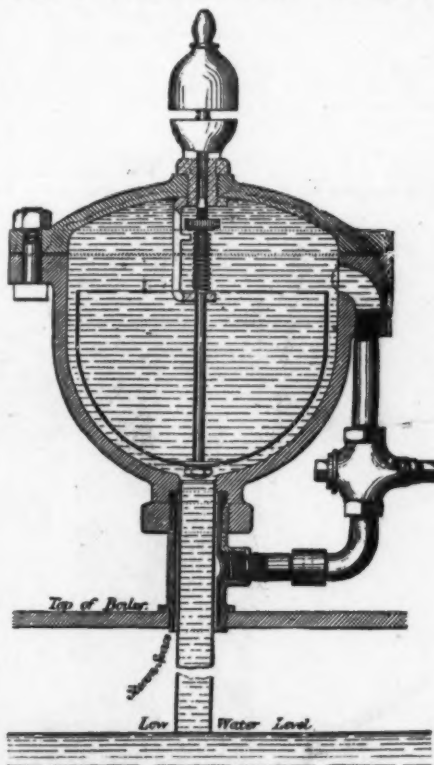
the cylinders, the cones C are driven into the strap by means of the hand-wheel which draws the valves from their facings sufficient for this purpose, the lock-nuts E come into contact with the strap when unscrewed, which prevents any undue pressure being put upon the cylinder facings.

The valves are simple and comparatively inexpensive in construction, and one advantage they possess is that no spring, plates, nor packing rings are employed, the steam surrounding all the parts except the bearing surfaces, and should the steam at any time cut through the facings, the valves can, in a few moments, be set to work with the full pressure of steam on and rebalanced when desirable. The cone part of the spindles also allows for wear.

KENYON'S LOW-WATER ALARM.

THE arrangement consists of a vase-shaped vessel fixed on the top of a short pipe which is screwed into the top of the boiler, this pipe having within it a second smaller pipe, which passes down into the boiler to low-water level. As will be seen from our engraving, the vase-shaped vessel has no direct communication with the first-named pipe which forms its support, but the annular space between the two pipes is placed in communication with the upper part of the vessel by a bent pipe furnished with a steam-cock, as shown on the right of our engraving.

Within the vase-shaped outer vessel is a light copper basin attached to a brass spindle, having a conical end which forms a valve stopping the lower end of the passage to the alarm whistle at the top of the apparatus. A small spiral spring made of hard brass and compressed so as to afford a resistance very slightly in excess of the weight it has to carry, serves to



support the copper basin and its spindle, and keep the opening to the whistle normally closed.

Under ordinary conditions the pressure in the boiler forces the water up the inner pipe, and fills the outer vessel and copper basin; but should the water in the boiler get below the bottom of the pipe, the water falls out of the vessel excepting the portion retained within the basin, which, acting as a dead weight, overcomes the slight resistance of the spring and steam pressure, and pulls the plug away from the opening to the whistle, when the steam, rushing up the pipe, sounds the alarm. The apparatus can at any time be tested by turning the handle of the steam cock upwards, which places the interior of the vessel in a state of equilibrium, when the water falls to the level of that in the boiler (excepting that contained in the basin, which can not escape), and the whistle is sounded; the vessel refills with water on closing the steam cock, which prevents the whistle being blown.—*Engineering.*

AMMONIA FROM THE NITROGEN OF THE AIR.

THE process of manufacturing hydrochlorate of ammonia is, according to the invention of Mr. E. Solvay, of Brussels, carried on in a lime-kiln or other furnace in which fuel and limestone or another base are charged and burnt, and it consists in drawing or forcing steam and air or nitrogen through the incandescent fuel and limestone or base. Chloride of calcium or another decomposing chloride is added to or mixed with the fuel or with the limestone or base, or hydrochloric acid gas is mixed with the steam and air or nitrogen passing through the kiln or furnace. Or ammonia may be manufactured by the use of a cyanide suitably heated in a retort, and the process consists in adding to a mixture of coal and baryta or other base in the retort a chloride capable of being more or less decomposed by steam, and applying thereto steam and air or nitrogen. Or in mixing hydrochloric acid gas with the steam and air or nitrogen which is to be injected into the mixture of coal and baryta or other base in the retort.

[Agricultural Gazette.]

A HISTORY OF LONGHORN CATTLE.

By J. NEVILL FITT.

PERHAPS there is no more difficult, and, at the same time, more interesting task, than the admirer of the roast beef of Old England, and the cattle whose mission it is to produce it, could propose to himself, than writing a history of the Longhorn breed of cattle—at one time the breed of the grazing districts. Since then they have in a great measure been lost sight of, and left in the hands of a few good men and true, in Warwickshire, Oxford, Leicester, Derby, and Lancashire; a few also amongst the hills of Cumberland and Westmoreland.

Men who knew their excellence, and when others "drooped and turned aside," seeking Shorthorn loves, pinned their faith on the docile tempers, widespread horns, and hardy constitutions of their long-lived cheesemakers and fillpalls, metaphorically nailing their colors to the mast, during years of neglect and depression, determined to do or die in their behalf. We believe it was our present Premier who said every thing comes to the man who waits, and right truthfully has the maxim been borne out in this case, for though their numbers have been few and scattered, the distances between them wide, and the cold shoulder, instead of the helping hand, too often proffered them in the showyard, the good qualities inherent in the breed, pluck on the part of the owners, and perhaps the conviction that one particular class of cattle is not the best adapted for all climes and all uses, are once more bringing the Longhorns into prominent notice, and with the foundations of a *Herd Book* laid at the last Birmingham show in Bingley Hall, and some really good prizes offered for them at the meeting of the Royal Agricultural Society in July next, they may fairly be said to have regained their legs, and to justify us in laying a history of them before our readers, the more so as we hope to be able to show conclusively that as a dairyman's or butcher's beast the Longhorn can hold his own against all comers, while for hardihood he ranks with the Welsh, Highland, or North Devon breeds, and loses nothing by the comparison.

Where did he come from, this singularly picturesque beast, with the carriage of a lion and the temper of a dove—the one breed, perhaps, in which the feeder, the butcher, and the artist may equally delight? There is no doubt as to his having been once spread pretty universally over our Midland Counties, and every reason to suspect that the loim from which the hungry Charles II. dined so well, that with a touch of the rollicking humor which afterwards got him the title of the Merry Monarch, he knighted it then and there as "Sir Loin," a title which it holds to this day, was cut from a Longhorn. Their origin is said to have been derived from the district of Craven, in Yorkshire.

Breeds of cattle, like nations and individuals, seem to have had their "cloudy day," as well as their time of fashion, or, as one would express it, their "dark ages." Certainly after occupying the place of honor and usefulness up to about the year 1815, the Longhorns were in a great degree displaced by the Shorthorns. However, the ancient fame and glory of the breed still had its spell upon many who had ceased to keep them, the "curly coats" and hardy constitution was well remembered as the heritage of the old brindled Longhorn, and how well they thrived on scanty pastures with little shelter. A Shorthorn man said: "I know the Longhorn breed well, and feel sure there are no more serviceable animals under the sun for general purposes, and I wish I had them now." A large landowner once remarked, "Since I gave up Longhorns no cattle have done so well on my estate as they did, and I shall endeavor to procure them again." The Longhorn breeders have been few in number, but, like the Freemasons, they kept loyally attached to their order, and labored hard to bring back departed glory, and revive "the light of other days."

Mr. R. H. Chapman's sale at Upton on December 16th, 1873, marks a new epoch in the breed, for on that occasion, purchases were made to found several new herds, old enthusiasm was revived, and it may be termed the modern "Bosworth Field" of peaceful industry. Earl Howe, who took the chair at the luncheon-table, was supported by county gentlemen and business men from far and near; round them hung the portraits and horns of many an Upton crack in years gone by. And when hunger was appeased, and people repaired to the sale ring, many a stout hand-to-hand encounter was fought out for the possession of their descendants. One two-year-old heifer realized 50 gu., and fourteen of the same age averaged £40 15s. 3d. The general average for 51 head was nearly £33, which included those sold to the butcher. Mr. Chapman reserved his calves and yearlings, the latter of which he sold near to Bingley Hall in 1874, when one heifer, named Brindled Beauty, realized £67 4s., and the twelve averaged nearly £37. Again in 1875, a part of the reserved calves were sold at the same place, when 15 averaged £34 15s., and Upton's Last Link made £49 7s. The 78 Mr. Chapman sold in two years averaged £34, or an aggregate of £2700, and he has reserved some heifers to breed from. Seven of the two-year-old heifers averaged £50 14s.

Though Mr. Chapman's herd is dispersed, there is still one of great purity at Upton Park, in the same parish, the property of Mr. Nicholas Taverner, whose uncle had a sale of Longhorns in 1794, in the adjoining parish of Fenny Drayton, when part of the produce of Mr. Fowler's bull, Washington, were sold—Mr. Taverner having secured this noted sire from Mr. Michael Buckley, who bought him for £315 15s. at the Rollright sale in 1791. Fenny Drayton is a place of some note, as George Fox, founder of the Quakers, or Society of Friends, was born there in 1624, and preached his first sermon under a tree in the vicinity, a spot long held in veneration by his followers; a monument, which may be seen by the roadside, in going from Nuneaton to Upton, has been erected to his memory near the spot.

Michael Drayton, the poet, born in 1563, derives his surname from this parish, and there is also a far less honorable legend attaching to it, which says that at about a mile off, near what is called "Feern Lane," the notorious highwayman, Dick Turpin, had a cottage, and that his famous mare, "Black Bess," was stabled in a cave near.

Amongst others who have reverted to the breed, is Mr. T. Levett Prinsep, the present owner of Croxall Hall, and a grandson of the great breeder, who was quite in the first rank 80 years ago. He commenced to found a new herd at Mr. Chapman's sale in 1873, and was recently chosen president of the Longhorn Society, to both of which events we shall refer further on.

Sir John Harper Crow, Bart., who for some years kept Shorthorns, has of late years gone in for Longhorn cattle, and has a very beautiful herd at Calke Abbey, which a year or so ago we had the pleasure of seeing.

A herd that has been in existence for at least three generations, is that of Mr. Thomas Setchwell, of Henfield, near Birmingham, as it was commenced by the grandfather of the present owner. He has used several bulls from the herd of the late Mr. Samuel Burbery, of Wroxall, and also one descended from the herd of Mrs. Baker, of Rollright, about twenty years ago; also a bull bred by Mr. Moore, of Knowle Hall, which was by Mr. Horton's noted bull, Old Conqueror, the 1st prize animal at the Royal show at Oxford in 1839. Mr. Setchwell's name is well known as a prize-taker at the Birmingham and Warwickshire shows. The Wroxall herd is of very long standing, having been started in the middle of the last century, and has won many prizes at the Birmingham show. The foundation of it was some very good and pure bred animals which came from Barton, in Derbyshire, and it was brought into great eminence by Mr. Jackson, who was an uncle of Mr. Burbery. The herd was sold at the death of Mr. Samuel Burbery in 1856, and realized good prices, one bull, afterwards a Royal prize winner, making 50 gs. The herd had been crossed with bulls from Lea of Canley, Smith of Smithfield, Slingaby of Foleshill, Baker of Rollright, Green of Odstone, and Holbrow of Churchdown. After the Wroxall sale, Mr. J. H. Burbery, of Kenilworth Chase, within bowshot of the Castle, brought a herd to great perfection, and won many prizes at Birmingham, London, and Warwick shows. This herd is now in the hands of his nephew, Mr. Forrest. Mr. Godfrey also possesses a herd which has made its mark in the showyard of the Royal Agricultural Society. We believe at the present time there are somewhere between thirty and forty gentlemen who have Longhorns, and amongst them the Duke of Buckingham, the Earl of Westmeath, Earl Howe, Lord Bagot, Sir J. Harper Crowe, Bart., Mr. C. N. Newdegate, M.P., Mr. T. Levett Prinsep, Mr. Townley Parker, Mr. W. T. Cox, etc. There are two herds near Lichfield, in Staffordshire, which have probably been in existence for 100 years, and which are reputed of great purity and excellence—one the property of Mr. Richard Brown, of Farewell, and the other belongs to Mr. W. S. Shaw, of Headley Old Hall. The ancestors of these gentlemen have sold Longhorns at great prices.

We may venture to hope that the foundation of a future era of usefulness was laid for this old breed, when a meeting was held in Bingley Hall, on the Monday of the last Birmingham show, of those interested in them, with the view of

Mr. Forrest proposed and Mr. Taverer seconded a third resolution, appointing a committee consisting of Sir J. H. Crowe, Bart., Mr. W. T. Cox, Mr. T. Levett Prinsep, Mr. J. H. Burbery, Mr. Townley Parker, Mr. R. H. Chapman, and Mr. Oxley, to consider and report to a general meeting to be held at Birmingham during the Royal show week in 1876.

Having thus traced the Longhorn history as far as we are able to obtain data, from the earliest records up to the present time, we may say that the Royal Agricultural Society offers prizes for them at its next meeting at Birmingham, as follows, when we expect to see them more strongly represented than ever they have been before (bulls over two years, £30 10s.; under two years, £10 5s.; cows over three years, £30 10s.; heifers under three years, £30 10s.; heifers under two years, £30 10s.), and make a few remarks on the breed as they have appeared at the fat stock shows of late years.

The weights of animals at any given age are a test of their early maturity, and therefore a comparison of various breeds in this matter is valuable. We will take the breeds as they stood in the catalogues at the Birmingham show, 1875, and compare them with Sir J. H. Crowe's Longhorn steer. In the

grand in a field full of Longhorns, and Mr. Chapman's grand old bull, the Earl of Derby, with 32 milking cows around him in the great meadow was a sight ever to be remembered by all admirers of live stock." Another point on which we have not touched is their length of days, for truly they are very Methuselahs amongst cattle, and their years are as long as their horns, so that "as old as a Longhorn cow" has passed into a proverb, and Bakewell's old Comely, one of his very best, and the foundation of some of his choicest strains, when killed at 36 years old, had four inches of fat on the sirloin. The length and thickness of horns vary with the sex, bulls being the shortest, and the horns of oxen the longest, the latter having been known to measure 7 or 8 feet from tip to tip, while those of the female are more tapering and finer. In color, the brindle, fawn, and pyc, with white backs, are the most common. Their maturity is early, as was proved when tested with some crack Shorthorn heifers, both being brought up together and living alike, when there was no perceptible difference between them in that matter. The propensity to fatten is good, and as we have said above, the dairy quality capital, while the offal is small. The breed was long known in Smithfield Market for affording the butcher the greatest number of valuable cuts along the back and ribs. The carcass is very cylindrical, the ribs standing well out, and the flesh of fine quality.

In the old days when shoe-buckles and wigs were in fashion, some eighty years ago, we have heard of a Longhorn breeder, who prided himself on his milking-cows, being able to carry his wig on one hip, and his hat on the other, their hips being like hat-pegs, so the old ladies of milk-pail fame could walk out from the homestead to their pastures carrying those exploded articles of attire.

The question has often been asked, "Why did the Long horns go out of fashion?" and it is easily answered. The principles of breeding were not understood a hundred years ago, and it was the aim of the great breeders to produce animals with very fine bone; this was carried to such an excess as to sacrifice both size and constitution. It was the same with the new Leicester sheep, and Buckley and his admirers used to boast of his breed that the bone of one of his legs of mutton was only the size of a tobacco-pipe. Mr. Buckley lived at Normanton Hill, near Robert Bakewell, of Dishley, and let one ram for 1000 gs., and another to the Duke of Bedford in 1807, for 700 gs.; and it has been said that at his ram-lettings, dukes, earls, baronets, and M.P.'s were as plentiful as blackberries.

To return, the male animal ought always to possess rough masculine properties; this necessary qualification was neglected both in Longhorns and Leicester sheep, consequently size, constitution, and early maturity were nearly lost. Again, the hind-quarters were considered of more importance than the fore ones, and big patchy rumps and hips thought necessary, and, in fact, the height of perfection; depth of ribs and largeness of chest being ignored or considered of secondary importance. Hence, after the decease of Webster, Fowler, Bakewell, and Prinsep, the herd rapidly declined, from having been brought to such a pitch of refinement as to render the propagation of calves very uncertain.

Breeders were slow to find out the defects to which we have alluded, consequently cultivated a wrong type of animal, and when unsuccessful laid the blame on the breed instead of their

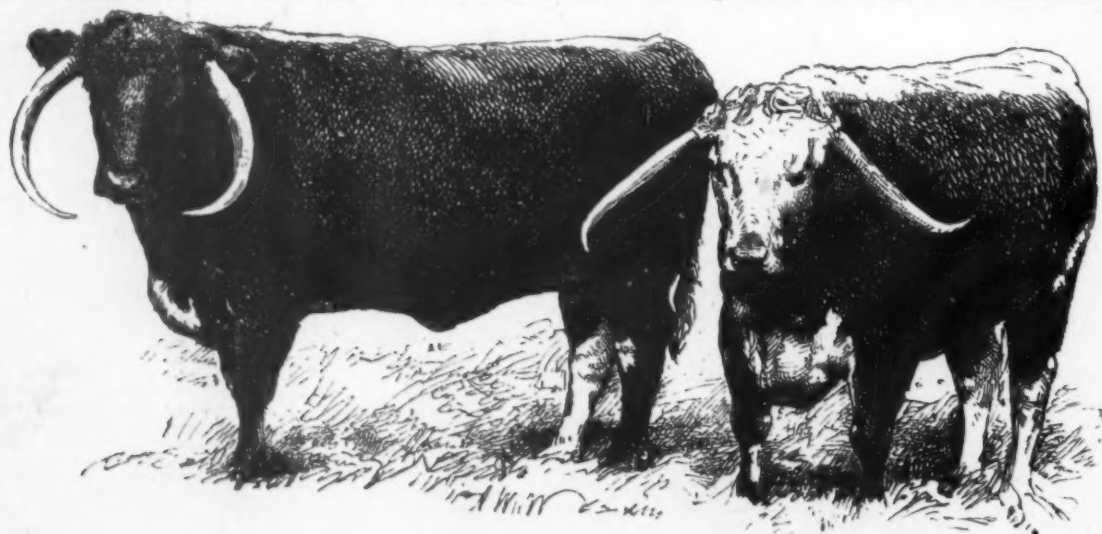


SIR JOHN CREWE'S LONGHORN COW, TULIP.

Hereford class for steers over four years old, two of them were less weight than the 3-year old Longhorn. Mr. Wortley's £109 prize steer as the best Hereford was 19 months older than the Longhorn, but only 136 lb. heavier. In the Hereford steers of the same age the weights were all much less than the Longhorn. In the Shorthorn steers of the same age as the Longhorn, four were less weight, and only one heavier. In the whole show only two steers of any breed, at the same age, were so heavy as the Longhorn.

We may also fairly take the prices cattle make as a test of value, especially when sold by public auction, unless, indeed, for the sake of fancy prices, the running-up system is resorted to, and the price actually paid, by previous agreement, much less than what the animal is knocked down at—a thing, we fear, not altogether unknown. This, it may be said, hurts no one, but surely it is deceiving the public, and unfair towards them.

From January 13th to November 5th, 1875, there have been 122 Shorthorn sales in England and America, of high-bred stock. Now, 33 of these herds made a less average than Mr.



SIR JOHN CREWE'S PAIR OF LONGHORN STEERS.

establishing that great desideratum, a Longhorn society, and start a herd-book.

Mr. T. L. Prinsep, of Croxton, presided, and a good number of breeders were present, amongst them being Col. Dyot, M.P., Mr. W. P. Cox, Mr. Oxley (from the Duke of Buckingham's), Mr. Townley Parker, Mr. R. H. Chapman, Mr. Godfrey, Mr. Setchwell, Mr. Taverer, and many others.

The chairman said he could bear evidence to the worth of the breed, for having tried it, he was perfectly surprised at the produce they gave. Devonshire cream could be as well made in Derbyshire as in the western county. He moved:

"That in consequence of the increasing interest manifested in Longhorns, and with the view of securing this old-established breed its proper position amongst English cattle, this meeting is of opinion that it is desirable to form a Longhorn society."

This was seconded by Mr. Setchwell. Mr. Townley Parker then moved:

"That believing purity of breed is essential to improvement, this meeting is further of opinion that the pedigree of Longhorns should be duly recorded, which object will be best obtained by establishing a Longhorn herd-book."

R. H. Chapman's Longhorns, and 23 about the same average, so here the test of value comes out very fairly, as we must remember that a part of the stock were sold to the butcher, and consequently could not be expected to realize breeders' prices. Mr. Chapman's sales are the only recent ones of the breed of which we have the figures to make comparison.

The Longhorns have also fairly held their own in the showyard when competing with other breeds. The Duke of Buckingham, at the county show in 1868, with his bull, Conqueror, bred by Mr. Godfrey, of Wigton, Parva, not only beat the highest Shorthorn in his class, but won the silver cup as the best beast in the yard, the judges being three Shorthorn men. Sir John H. Crowe, Mr. Burbery, Mr. Godfrey, Mr. Cox, and Mr. Chapman have also reaped laurels from other breeds.

As regards milk and cream, it is a well-known axiom, that though you may skim a Shorthorn's milk with a feather, a mouse may run over the cream of a Longhorn without fear of falling through; in fact, they are as hardy and profitable a breed as could be found, while as regards appearance we know of no greater ornament either to park or pasture than a herd of these picturesque beasts. The Druid, from whom we have before quoted, says: "There is something very quaint and

own error in judgment. Those of the present day are wiser in their generation, and, having found out the mistake, now produce animals remarkable for their hardy constitutions, muscular properties, and great size; and in the Midlands—as it were, in his native soil and climate—the Longhorn answers better for dairy work than any other breed. They have also reached great excellence in Yorkshire, and thence spread into Cumberland and Westmoreland, to which county Mr. R. Chapman has of late years gone for bulls.

We must now take our leave of this interesting breed, feeling that they only want "a fair field and no favor," to once more hold a far more important place in public estimation than they have recently done. Fancy cattle we have no wish to see them become; for although fictitious value, when reached by any breed, may be the means of large pecuniary gains to owners and breeders, it is of no national benefit, and we fail to see the intrinsic value of a breed which has been brought to such a pitch of perfection (sic) that it must die out, unless more useful dairy cows than its queens can be found to suckle the calves. We should be content to see the Longhorns stop far short of this, and fulfil their mission in making beef, cheese, and butter.

